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FRANK A. TAYLOR
Director, United States National Museum

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A REVIEW OF THE OPHIDIOID FISH GENUS OLIGOPUS WITH THE DESCRIPTION OF A NEW SPECIES FROM WEST AFRICA

By DANIEL M. COHEN

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Volume 116 1964 Number 3494

A REVIEW OF THE OPHIDIOID FISH GENUS OLIGOPUS WITH THE DESCRIPTION OF A NEW SPECIES FROM WEST AFRICA

By DANIEL M. COHEN[1]

Introduction

This paper defines the genus *Oligopus*, presents a discussion of generic synonymy, and gives diagnoses of six species, one of which is described herein as new to science.

The species of *Oligopus* have numerous fin rays and small scales, as is true of many other ophidioids. Because the bases of the fin rays almost invariably are obscured by darkly pigmented skin, most counts of vertical fin elements were made from X-ray photographs. In addition, internal skeletal characters were observed only from X-ray photographs. Examination of the head pores was aided by the use of a compressed air jet.

These fishes secrete a thick mucous coat that often makes it difficult to count scales and to observe pores. Also, the papillae that mark

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the course of the lateral line are fragile structures which may be lost when the mucous coat is removed.

Following are the definitions of some of the terms and abbreviations used in this paper: Predorsal: shortest distance between tip of snout and a vertical through origin of dorsal fin; preanal: shortest distance between tip of snout and a vertical through origin of anal fin; SL: standard length; HL: head length; upper jaw: shortest distance between tip of snout and posterior margin of maxillary; greatest depth of maxillary: depth at posterior expanded region of bone, but not including downward projecting maxillary spine; greatest head width: width of head with opercular flap compressed; D: dorsal fin rays; A: anal fin rays; caudal fin rays: only those rays articulating with hypural plate; vertebrae: count not including hypural; lateral scale rows: counted from upper angle of opercle; head canals: terminology follows Robins (1959).

I have examined material deposited in the following institutions, and I am much indebted to their respective curators: Academy of Natural Sciences of Philadelphia (ANSP); British Museum (Natural History) (BMNH); Museum of Comparative Zoology at Harvard University (MCZ); Rhodes University, Grahamstown, South Africa (RU); Scripps Institution of Oceanography (SIO); Stanford University, Division of Systematic Biology (SU); University of Bergen Zoological Museum (UBZM); University of Copenhagen Zoological Museum (UCZM); University of Hawaii (UH); U.S. National Museum (USNM); University of Puerto Rico (UP). Mr. Luis Rivas has furnished me with information concerning the type of *O. claudei*. Mr. and Mrs. Craig Phillips have donated a specimen of *Stygnobrotula*. Dr. Frank H. Talbot and Mr. W. I. Follett X-rayed the type of *Eutyx diagrammus*. Mr. Jørgen Nielsen X-rayed the type of *Bythites fuscus*. Mr. Alwyne Wheeler X-rayed specimens in the British Museum. I particularly thank my colleagues Dr. Bruce B. Collette and Dr. Ernest A. Lachner for their advice during the course of this study and for their critical review of the manuscript.

Genus *Oligopus* Risso

Oligopus Risso, 1810, p. 142 (type species by monotypy *Oligopus ater* Risso, 1810).

Gadopsis (not Agassiz, 1845; not Richardson, 1848) Filippi, 1856, p. 170 (type species by monotypy *Oligopus ater* Risso, 1810).

Grammonus Gill *in* Goode and Bean, 1896, p. 315 (type species by monotypy *Oligopus ater* Risso, 1810).

Verater Jordan, 1919a, p. 343 (proposed as a replacement name for *Pteridium* Filippi and Verany, 1859; however, these authors used *Pteridium* Scopoli, 1777. Type species by original designation of Jordan *Oligopus ater* Risso).

Eutyx Heller and Snodgrass, 1903, p. 224 (type species by monotypy *Eutyx diagrammus* Heller and Snodgrass, 1903).

Bathystorreus Howell Rivero, 1934, p. 69 (type species by original designation *Benthocometes claudei* Torre, 1930).

DIAGNOSIS.—Gill membranes separate. Chin barbel absent. Live-bearing. Pelvic fins each with one ray, originating close to level of posterior margin of preopercle and about an eye diameter behind symphysis of cleithra; vertical fins continuous, covered proximally with thick, scaleless skin; pectoral fin entire, without separate, elongated rays. Head partly naked, bearing dermal papillae; anterior nostril tubular, located directly above upper lip; gill rakers 2 or 3; tongue a massive structure with anterior, prowlike projection fitting between 2 heads of geniohyoideus muscle. Branchiostegal rays 8. Body relatively short, stubby; head not depressed, height greater than width. Lateral line with 2 or more series, dorsal and ventral sometimes overlapping or parallel for entire lengths; palatine lacking teeth; ventrally directed projection usually present at posteroventral section of maxillary; posterior portion of maxillary expanded. Eyes well developed. Body completely covered with small cycloid scales. Lining of peritoneum pale in color.

First neural spine low; neural spines 2, 3, 4 raised, followed by series of low neural spines with more or less truncate tops (fig. 1). Vertebrae 1 and 2 without ribs; vertebra 3 with pair of anteroventrally directed ribs; vertebrae 4–6 with posteroventrally directed ribs articulating with centra; vertebra 7 with ribs attached, free or at end of parapophyses; vertebrae 8–10, 11 or 12 with ribs at ends of parapophyses; all other vertebrae lacking pleural ribs.

RELATIONSHIPS.—*Oligopus* is a distinctive group of well-differentiated species. The genus apparently represents a rather generalized type of ophidioid, at least among the live-bearers, and this fact, along with its relatively shallow-water habitat, suggests that, together with *Bythites*, *Oligopus* may be close to the stem from which various forms descended toward an abyssal habitat while others colonized the coral reefs: *Oligopus* has affinities with fishes that dwell in both areas.

Among the reef inhabitants, *Microbrotula*, *Grammonoides*, and *Stygnobrotula* are related to *Oligopus;* the former two even possess the peculiar projection on the maxillary. None of the three genera, however, displays the peculiar shortened and truncate neural spines (fig. 1) that are characteristic of *Oligopus;* moreover, *Microbrotula* has palatine teeth, and Böhlke (1957) has given a number of reasons for separating *Stygnobrotula* from *Eutyx* (here considered a junior synonym of *Oligopus*), most of which serve to separate *Stygnobrotula* from the more inclusive genus *Oligopus*. Particularly important are Böhlke's items 1, 2, 3, 4, 6, 7, 9, and 13 of his table 1, p. 3, to

which the reader is referred.[2] *Grammonoides* is also different in dentition, lacking the bands of granular teeth on the premaxillary and the dentary.

Among the genera confined to deeper water, the closest relatives of *Oligopus* are those forms with a tubular anterior nostril placed directly over the upper lip, reduced squamation on the head, and a single ray in each ventral fin. This group includes *Diplacanthopoma*, *Myxocephalus*, the species presently assigned to *Cataetyx* (at least two genera are included in this group), and *Bythites*. All of these differ from *Oligopus* in possessing palatine teeth, and in lacking shortened, truncate neural spines. In addition, *Diplacanthopoma* and *Myxocephalus* lack scales on the head. Most of the species of *Cataetyx* (though not the type, *C. messieri*) have strongly depressed heads.

Oligopus ater, the type species of *Oligopus*, long has been considered congeneric with a superficially similar species that was described originally by Doderlein (1886) as *Pteridium armatum*. Bougis and Ruivo (1954) reported on specimens that they identified as *Benthocometes robustus*, a name that they treated as a senior synonym of *P. armatum*. They illustrated (their fig. 19) specializations of the anterior vertebrae that bear some resemblance to those long known to exist in the Ophidiidae (in the restricted sense), but there is some conflict in this identification, for Doderlein (1886) did not show modified anterior vertebrae in his figure of a dissection of *Pteridium armatum*. These structures, however, have been shown to be sexually dimorphic in the ophidiid genus *Ophidion* (Rose, 1961). Whatever the identity of *P. armatum*, *Oligopus* differs widely both from Doderlein's description and from *Benthocometes*. It is of interest to note that another species of *Oligopus* (*O. claudei*) was also confused with *Benthocometes*.

The foregoing discussion is based on the material listed below.

MATERIAL EXAMINED.—*Benthocometes robustus* (USNM 29057, paratype); *Bythites fuscus* (UCZM, holotype); *Bythites lepidogenys* (USNM 74152, holotype); *Cataetyx hawaiiensis* (USNM 162715, holotype); *Cataetyx laticeps* (UBZM, holotype); *Cataetyx messieri* (BMNH, holotype); *Diplacanthopoma brachysoma* (BMNH, holotype); *Diplacanthopoma brunnea* (USNM 74148, holotype); *Grammonoides opisthodon* (RU, holotype); *Microbrotula rubra* (USNM 162710, holotype); *Myxocephalus japonicus* (USNM 160604); *Stygnobrotula latebricola* (USNM 187777); *Xenobythites armiger* (USNM 74153, holotype).

SYNONYMY.—In his original description of *Oligopus ater*, Risso (1810) credited the genus *Oligopus* to Lacépède; however, Risso's

[2] Boeseman (1960) overlooked the description of *Stygnobrotula latebricola* and described the same species as *Eutyx tumidirostris*.

spelling is an unjustified emendation of *Oligopodus* Lacépède, 1800, proposed for *Coryphaena velifera* Pallas, and therefore, *Oligopus* is available from 1810 with Risso as the author.

Swainson (1839) placed *O. ater* in *Pteridium* Scopoli, and Filippi (1856) proposed the generic name *Gadopsis* (already twice preoccupied) for the species. Filippi and Verany (1859) then accepted *Pteridium* Scopoli (proposed for *Coryphaena velifera* Pallas) for *O. ater* and have been followed by numerous authors. Gill (*in* Goode and Bean, 1896) proposed *Grammonus* for *Oligopus ater* Risso, with no comment.

Verater was first proposed by Jordan (1919a) as a substitute for *Pteridium* Filippi and Verany although these authors plainly indicated they were following Swainson, who used *Pteridium* Scopoli; however, in a later publication during the same year, Jordan (1919b) presented *Verater* as a replacement name for *Gadopsis* Filippi, with *O. ater* Risso as the type species.

Heller and Snodgrass compared *Eutyx* with *Grammonus* Gill and separated the two on the grounds that the former genus lacked an opercular spine, had a double lateral line, and had large muciferous canal openings on the head. Actually, *Eutyx* may have its small opercular spine hidden or exposed (Böhlke, 1957, and the present author); its lateral line (described below under *Oligopus diagrammus*) is similar to that in other species of the genus, and all of the species here referred to *Oligopus* have canal openings on the head.

Bathystorreus was proposed for a species originally described in *Benthocometes*, where it obviously did not belong. The single known specimen is in bad condition; however, an X-ray photograph showing the abdominal vertebrae gives reason enough to place this species in *Oligopus*.

SPECIES.—Six species are referred herein to *Oligopus*. Although the available material of most is limited, a few suggestions concerning relationships and distributions can be presented. *O. claudei* from the tropical western Atlantic is distinct from all other *Oligopus*. Distinct preopercular spines and numerous head pores are its distinguishing characters. *O. diagrammus* is known from Galapagos, Guadalupe, and lower Baja California. The material suggests the presence of a species complex or a group of subspecies. *O. diagrammus* has a reduced number of head pores but high fin ray and vertebral counts. Apparently it is most distantly related phylogenetically to the western Atlantic species. The other species are *O. longhursti* (herein described as new), known from tropical West Africa; *O. ater* from the Mediterranean; *O. robustus* from Japan, the Philippines, and the Indian Ocean; and *O. waikiki* from Hawaii. The latter, wide-ranging group of four species is intermediate phylogenetically as

well as geographically between the western Atlantic and the eastern Pacific species.

I do not consider *Grammonus leucos* Osorio, 1917, to be referable to *Oligopus*, as the original description mentions the presence of teeth on the palatines. Professor Fernando Frade has informed me that the type cannot be found in the Museu Bocage.

Key to Species of *Oligopus*

1a. One or no pores in lateral head canal system; 1 or 2 pores in supraorbital canal. Spines along preopercle margin absent or small and weak.
2a. Dorsal fin rays 68–87; anal fin rays 51–62; vertebrae 40–46.
3a. Dorsal fin rays 68–74; anal fin rays 51–52; vertebrae 40–42 . . . **O. ater**
3b. Dorsal fin rays 83–87; anal fin rays 57–62; vertebrae 44–46.
4a. Lateral scale rows about 120. Upper row of lateral line organs about 35–45; lower about 35–40; dip in ventral lateral line in vent area . . . . . **O. longhursti**
4b. Lateral scale rows about 75–85. Upper row of lateral line organs about 21; lower row about 25–30; no dip in ventral lateral line. **O. robustus**
2b. Dorsal fin rays 93–115; anal fin rays 71–91; vertebrae 48–53.
5a. Lateral scale rows about 80; anal fin rays 71; 6 pores in infraorbital canal system . . . . . **O. waikiki**
5b. Lateral scale rows 97–115; anal fin rays 76–91; 5 or fewer pores in infraorbital canal system . . . . . **O. diagrammus**
1b. Three or 4 pores in lateral head canal system; 2, 3, or 4 pores in supraorbital canal. Several small but distinct spines along preopercle margin. **O. claudei**

Oligopus ater Risso

PLATE 2

Oligopus ater Risso, 1810, p. 142, pl. 11, fig. 41 (original description, Gulf of Saint Hospice, France).—Fowler, 1936, p. 1329 (description, synonymy).

Oligopus niger Risso, 1826, p. 338 (new name for *O. ater* Risso, 1810; description).

Pteridium ater Swainson, 1839, p. 302 (*O. ater* Risso listed under *Pteridium* Scopoli).

Gadopsis ater Filippi, 1856, p. 170 (description of swim bladder, new genus proposed).

Pteridium atrum Filippi and Verany, 1859, p. 195, fig. 6 (synonymy, description, swim bladder, relationships).—Doderlein, 1886, p. 73 (comparison with *Pteridium armatum*).—Günther, 1887, p. 105 (description, 1 specimen from Mediterranean).—Bellotti, 1888, p. 222 (sexual dimorphism in dentition of specimens from Nice and nearby, comparison with *Pteridium armatum*.)—Lo Bianco, 1909, p. 741 (pelagic postlarvae circa 30 mm., January, February, March, in Gulf of Naples).—D'Ancona, 1938, p. 159, figs. 2, 4, 8 (comparison with *P. armatum*, description, based on material from Nice, Naples, and Zirona, nomenclature, relationships, distribution, additional references not here cited).

Grammonus ater Goode and Bean, 1896, p. 317 (new genus proposed, synonymy, compiled description).—Tortonese, 1958, p. 333 (listed, doubts that *G. ater* (Risso) and *G. armatus* (Doderlein) belong in different genera).

Verater ater Jordan, 1919a, p. 343 (new genus proposed).

Misidentifications: *Pteridium atrum* Emery, 1885, p. 158, fig. 21 (30 mm. specimen, description, probably *Benthocometes robustus*).—Roule and Angel, 1930, p. 110, pl. 6, fig. 146 (Azores, description of postlarvae).

STUDY MATERIALS.—1 specimen, Nice, MCZ 26457.

COUNTS AND MEASUREMENTS.—(Measurements given in mm., followed by percent of standard length in parentheses) D 74; A 52; pectoral 19; vertebrae 40; caudal 10; vertical scale rows about 83; SL 89; body depth at dorsal origin 17.5 (19.7); predorsal 31.2 (35.0); preanal 50.0 (56.1); HL 25.0 (28.0); snout 5.8 (6.5); orbit 3.0 (3.4); upper jaw 14.2 (15.9); greatest maxillary width 4.5 (5.1); greatest head width 11.0 (12.3). (See D'Ancona, 1938, p. 162, for additional data.)

DESCRIPTION.—Squamation: Scales present on large area on top of head behind eye level; present on side of head on opercle and in area ahead of opercle extending forward nearly to eye and ventrally to region behind maxillary. Dorsal and lateral scale patches separated by scaleless lateral canal.

Lateralis system: Lateral canal with single pore near upper angle of opercle. Supraorbital canal with 2 pores: 1 in front of, and below, anterior nostril; the other, difficult to find, above anterior nostril. Infraorbital canal with 6 pores: 3 beneath nostrils in skinfold over upper jaw; 1 very small pore close to level of posterior part of eye; 2 larger pores above posterior expanded part of maxillary. Preoperculomandibular canal with 8 pores: 2 at tip of dentary, 1 opening anteriorly, the other posteriorly; 1 beneath lower lip at about midlength of snout; 1 at about midlength of jaw; 1 slightly ahead of posterior margin of maxillary; 1 slightly behind same; 2 on posterior margin of preopercle.

Circumorbital and interorbital areas and side of snout cavernous, covered with thick skin bearing scattered papillae. Interorbital area particularly rugose.

Lateral line marked by small, dark, dermal filaments. Series of 23 originates above opercle. Between opercle and level of dorsal fin origin filaments in elongate, irregular cluster from which lateral line extending posteriorly in straight line, between midline and dorsal profile. Dorsal line terminating 63 mm. from tip of snout. Second line of about 40 filaments originating in midline close to level of posterior tip of pectoral fin, descending, then rising to midline of body to form shallow irregular semicircle with lowest point opposite vent, then extending straight back in midline of body to tail. Filaments similar to those along lateral lines scattered about on head.

Dentition: Premaxillary with band of uniform granular teeth. Dentaries with similar teeth and irregular row of larger, conical teeth along inner edge of granular band. Head of vomer a broad

V with arms expanded. Both short granular and larger conical teeth present on vomer. According to Bellotti (1888), females of this species have the type of dentition noted above, although without larger teeth on the vomer, while males have both larger teeth and granular teeth on the premaxillary, vomer, and dentary.

Head spines: Short, sharp-pointed spine piercing skin at upper corner of opercle. Posteroventral margin of preopercle with 2 blunt projections at angles. Ventrally directed spine at end of maxillary prominent, piercing skin.

Vertebrae and ribs: Neural spines 5–13 short and broad but becoming progressively more elongate and narrower, their tips truncate; neural spines on subsequent centra needle-like. Centra 7–11 with ribs at ends of parapophyses, subsequent centra lacking pleural ribs. Centra 4–8 with epipleurals attached to pleural ribs; on centra 9–12 epipleurals appear associated with parapophyses.

Color: Body light brown, vertical fins and head darker. Long in preservative, this specimen evidently was much darker in life. Risso used the common name "fanfre negre" and stated that the species was black.

DISTRIBUTION.—Known from the area around Nice, from Naples, and from several localities in the Adriatic. Little is known of its depth distribution.

HABITAT.—Dwells in rocky areas in caves, according to Risso (1810), and apparently is secretive.

COMMENTS.—Professor D'Ancona (1938) has presented an excellent review of this species, and his paper should be consulted for information and references not given here.

Oligopus longhursti, new species

PLATE 3

STUDY MATERIAL.—All females. Holotype: USNM 187778, off Lagos, Nigeria in 5–10 fathoms, otter trawl, collected by A.R. Longhurst, August 1961. Paratypes: USNM 187779, 1 specimen, data as for holotype; USNM 191732, 2 specimens, Monrovia, Liberia, Bush Rod Island, beach seine, collected by George C. Miller, October 7, 1952; USNM 193678, 1 specimen, Liberia, 3–7 fathoms off mouth of St. Paul River, trawl, collected by George C. Miller, October 14, 1953.

COUNTS AND MEASUREMENTS.—See table 1.

DESCRIPTION.—Squamation: Scales present on large area on top of head behind eye level; present on side of head over opercle and area in front of dorsal half of opercle, which extends to within eye diameter of eye. Lateral scale patch bounded dorsally by scaleless

lateral canal and ventrally by scaleless area that demarcates separate patch of scales posterior to rear margin of maxillary.

Lateralis system: Lateral canal with 1 pore near upper angle of opercle. Supraorbital canal with 2 pores: 1 in front of anterior nostril; the other, very small, above anterior nostril. Infraorbital canal with 5 or 6 pores: 3 in row behind anterior nostril; 1, very small, near level of posterior margin of eye (absent in USNM 193678); and 2 above posterior expanded portion of maxillary. Preoperculomandibular canal with 8 pores: 2 at tip of dentary, 1 opening anteriorly, the other posteriorly; 1 beneath lower lip close to level of posterior nostril; 1 slightly ahead of level of posterior margin of maxillary; 1 near lower angle of same; 2 shaped like elongate slits, on posterior margin of preopercle.

Circumorbital and interorbital areas and side of snout cavernous and covered with thick skin bearing many small, dark, dermal papillae similar to those marking course of lateral lines along side of body. These filaments particularly abundant in interorbital region.

One series of lateral line filaments numbering about 35–45 and originating on head above opercle and, after slight irregular dip near origin, extending posteriorly in straight line between midline of dorsal profile, this dorsal line terminating more than half way back along body. Second line of about 35–40 filaments originating at about midline close to level of posterior tip of pectoral fin, descending, then rising to midline of body to form irregular semicircle having lowest point opposite origin of anal fin, then extending in straight line in midline of body to tail.

Dentition: Premaxillary bearing uniform band of granular teeth. Dentaries bearing similar teeth plus irregular row of larger, conical teeth along inner edge of granular band. Head of vomer with widely spread wings bearing short granular teeth. All four specimens females.

Head spines: Short, weak spine present at upper corner of opercle. May be buried beneath skin and invisible without dissection, or barely visible at its tip. Posteroventral margin of preopercle may be completely rounded or show 2 slight angles. Maxillary spine varying from prominent projection pictured in holotype to virtually absent condition in 1 Liberian paratype.

Vertebrae and ribs: Neural spines 5–13 short and broad but becoming progressively more elongate and narrower, their tips more or less (5 and 13) truncate; neural spines on subsequent centra needle-like. Centra 7–12 with ribs at ends of parapophyses, subsequent centra lacking pleural ribs. Centra 4–9 with epipleurals attached to pleural ribs; on centra 10–13 epipleurals appearing to be associated with parapophyses.

724-329—64——2

Color: Head and body brown, vertical fins black. Beneath superficial brown pigmentation of scales and scale pockets large, dark chromatophores distributed regularly on body.

DISTRIBUTION.—Known only from the type localities. Taken in a beach seine and at 3–10 fathoms.

COMMENTS.—The holotype extruded fertilized eggs that must have been close to hatching and that are about 0.9 mm. in diameter. The Nigerian paratype has paired ovaries about 25 mm. long. Each contains an estimated 3,000 unfertilized eggs (based on counts and volumetric displacement on ½ of 1 ovary), which are about 0.5 mm. in diameter. Eggs are of about the same size in all parts of the ovary; however, the eggs closest to the posterior end are more densely granular. One Liberian paratype (USNM 191732) extruded granular (unfertilized) eggs of about 0.5 mm. in diameter. The other Liberian specimen has its ovaries packed with an estimated several thousand young fish. The embryos are between 4 and 5 mm. long and have small yolk sacs and open choroid fissures. Elongate processes are attached to the embryo a short distance behind the yolk sac.

***Oligopus robustus* (Smith and Radcliffe)**

Grammonus robustus Smith and Radcliffe *in* Radcliffe, 1913, p. 168, pl. 13, fig. 4 (original description, "*Albatross*" St. 5409, 10°38′ N., 124°13′ E.—Norman, 1939, p. 79 (Gulf of Aden, 457–549 m.).—Kamohara, 1954, p. 5, fig. 3 (5 specimens from Kochi market, description).

Bythites lepidogenys (not Smith and Radcliffe, 1913) Kamohara, 1952, p. 93 (3 specimens from Mimase, description).

STUDY MATERIAL.—Holotype, USNM 74149, male.

COUNTS AMD MEASUREMENTS.—(Measurements given in mm., followed by percent of standard length in parentheses) D 87; A 62; pectoral 25; vertebrae 46; caudal 8; vertical scale rows about 75; SL 129; body depth at D origin 32.5 (25.2); predorsal 42.2 (32.7); preanal 71.1 (55.1); HL 40.4 (31.3); snout 6.5 (5.0); orbit 6.5 (5.0); upper jaw 22.0 (17.1); greatest maxillary width 8.2 (6.4); greatest head width 21.2 (16.4). Additional meristic and morphometric data are presented by Kamohara (1954).

DESCRIPTION.—Squamation: Patch of scales present on nape. On sides of head, scales present on opercle and on area in front of opercle extending forward nearly to eye, dorsally to level of top of opercle, where scaleless lateral canal separates dorsal and lateral scale patches, and ventrally to area behind maxillary.

Lateralis system: Lateral canal with 1 pore near upper angle of opercle. Supraorbital canal with 2 pores: 1 below, and in front of, anterior nostril tube; the other immediately above tube. Infraorbital canal with 6 pores: 3 beneath nostrils over upper lip; 1 at

level of posterior part of eye; 2 above posterior expanded portion of maxillary. Preoperculomandibular canal with 8 pores: 2 at tip of dentary, 1 opening anteriorly, the other posteriorly; 1 beneath lower lip near level of posterior nostril; 1 close to midlength of jaw; 1 ahead of posterior margin of maxillary; 1 behind same; 2 at posteroventral angle of preopercle.

Small, dark papillae scattered on head, concentrated in interorbital area. Lateral line marked by papillae similar to those on head. One series of 21 originating above opercle and, after slight irregular dip near origin, extending posteriorly in straight line between midline and dorsal profile, terminating at level of vent. Second line of about 25 filaments originating in midline at level of origin of anal fin and extending posteriorly in midline of body to point about 10 mm. from tail (the tail has become somewhat abraded and in all likelihood the lateral line actually continues to the base of the tail as shown by Radcliffe, 1913, and Kamohara, 1954.)

Dentition: Premaxillaries, dentaries, and broadly V-shaped vomer bearing bands of uniformly small, granular teeth.

Sex: Specimen male with prominent, paired testes about 20 mm. long.

Head spines: Small, sharp-pointed spine piercing skin at upper angle of opercle. Posteroventral angles of preopercle with 2 very blunt points. Maxillary spine prominent on right side of specimen, weakly developed on left side.

Vertebrae and ribs: Neural spines 5–15 short and broad, but becoming progressively more elongate and narrower; their tips truncate; neural spines on subsequent centra more needle-like. Centra 7–11 with ribs at ends of parapophyses, subsequent centra lacking pleural ribs. Centra 4–7 with epipleurals attached to pleural ribs; on centra 8–15 epipleurals appearing to be associated with parapophyses.

Color (in alcohol, quoted from original description): "Wood-brown; dorsal and anal dusky anteriorly, becoming dark clove brown posteriorly; the basal portion of caudal clove brown, distal portion somewhat lighter; pectorals dusky; peritoneum silvery gray."

DISTRIBUTION.—Known from Mimase, Japan; the Philippines between Cebu and Leyte, at a depth of 189 fathoms on a green mud bottom; and the Gulf of Aden between 25 and 30 fathoms.

***Oligopus waikiki*, new name**

PLATE 4

Microbrotula nigra Gosline, 1953, p. 220, fig. 1d (original description, off Waikiki Reef, Oahu, Hawaii).[3]

[3] If *Microbrotula nigra* Gosline is referred to *Oligopus*, the specific name must be rejected as a junior secondary homonym of *Oligopus niger* Risso, which is a junior synonym of *Oligopus ater* Risso.

STUDY MATERIAL.—Holotype of *Microbrotula nigra*, USNM 179898, formerly UH 1684, female.

COUNTS AND MEASUREMENTS.—(Measurements given in mm., followed by percent of standard length in parentheses) D 98; A 71; pectoral 26; vertebrae 48; caudal 8; vertical scale rows about 72; SL 61.4; body depth at D origin 17 (27.7); predorsal 16.8 (27.4); preanal 30.0 (48.9); HL 15.9 (25.9); snout 3.2 (5.2); orbit 3.0 (4.8); upper jaw 9.0 (14.7); greatest maxillary width 3.6 (5.9); greatest head width 9.5 (15.5).

DESCRIPTION.—Squamation: Patch of scales present on nape. Second patch covers opercle and dorsal half of area in front of it, extending forward to within eye diameter of eye. Small, separate patch consisting of few scales present behind rear margin of maxillary.

Lateralis system: Lateral canal lacking pores. Supraorbital canal with 2 pores: 1 below, and in front of, anterior nostril tube; the other, very small, above tube. Infraorbital canal with 6 pores: 3 beneath nostrils over upper lip; 1 at level of posterior part of eye; 2 above posterior expanded portion of maxillary. Preoperculomandibular canal with 8 pores: 2 at tip of dentary, 1 opening anteriorly, the other posteriorly; 1 beneath lower lip near level of posterior nostril; 1 close to midlength of jaw; 1 slightly ahead of level of posterior margin of maxillary; and 3 shaped like elongate slits along posteroventral and posterior margin of preopercle.

Small, dark papillae scattered on muzzle and interorbital region. Lateral line marked by papillae. One series of about 20 originating above opercle and, after dip near origin, extending posteriorly to level of vent. Second line of about 35 papillae originating in midline at level of origin of anal fin and extending posteriorly in midline of body to tail, although posterior papillae very small.

Dentition: Premaxillaries and dentaries bearing bands of uniformly small, granular teeth. Vomer with 2 patches of similar teeth. Although Gosline (1953) noted the presence of palatine teeth, I find no trace of them.

Sex: Specimen female with small embryos in ovaries.

Head spines: Small, sharp-pointed spine piercing skin at upper angle of opercle. Posteroventral angles of preopercle bearing several weakly spinous points. Maxillary spine prominently developed.

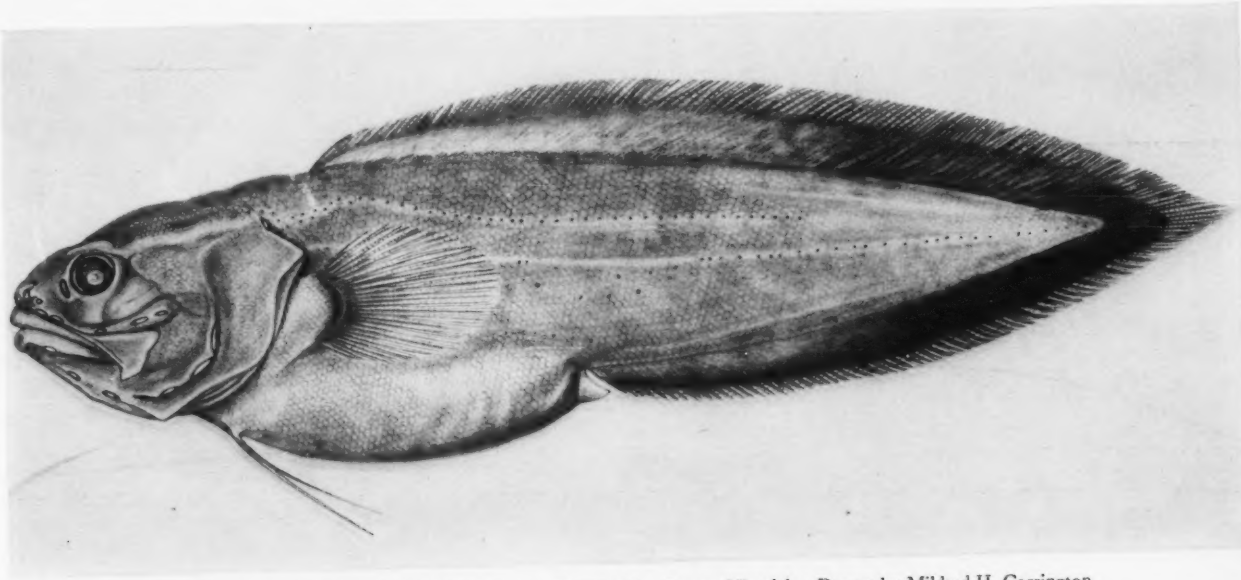
Vertebrae and ribs: Neural spines 5–14 short and broad, but becoming progressively more elongate and narrower, their tips truncate; neural spines on subsequent centra more needle-like. Centra 7–11 with ribs at ends of parapophyses, subsequent centra lacking pleural ribs. Centra 4–8 with epipleurals attached to pleural ribs; on centra 9–12 epipleurals appearing to be associated with parapophyses.

Color: Body brown, fins darker.

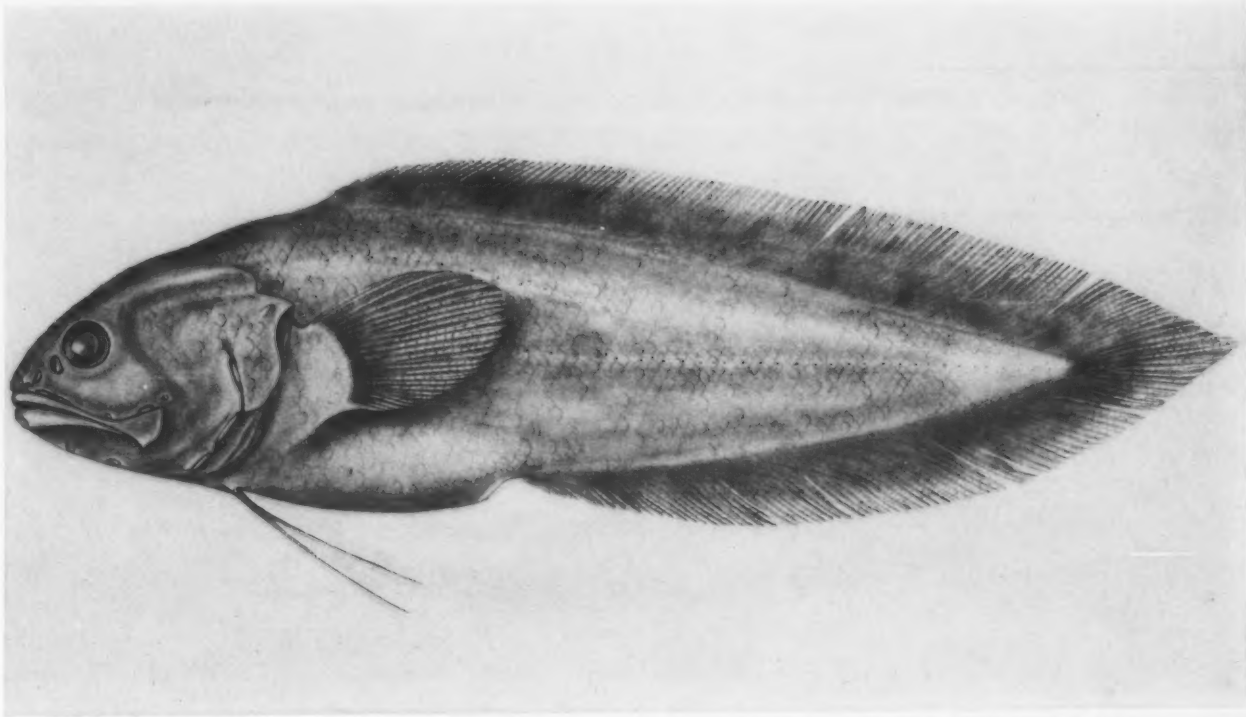
DISTRIBUTION.—Known only from the type locality at about 30 feet.

X-ray photograph of *Oligopus diagrammus* (SIO H53-169, 185 mm. SL. Guadalupe Island, Mexico). Photograph by William L. Witt.

Oligopus ater (MCZ 26457. 89 mm. SL. Nice, France). Drawn by Mildred H. Carrington.

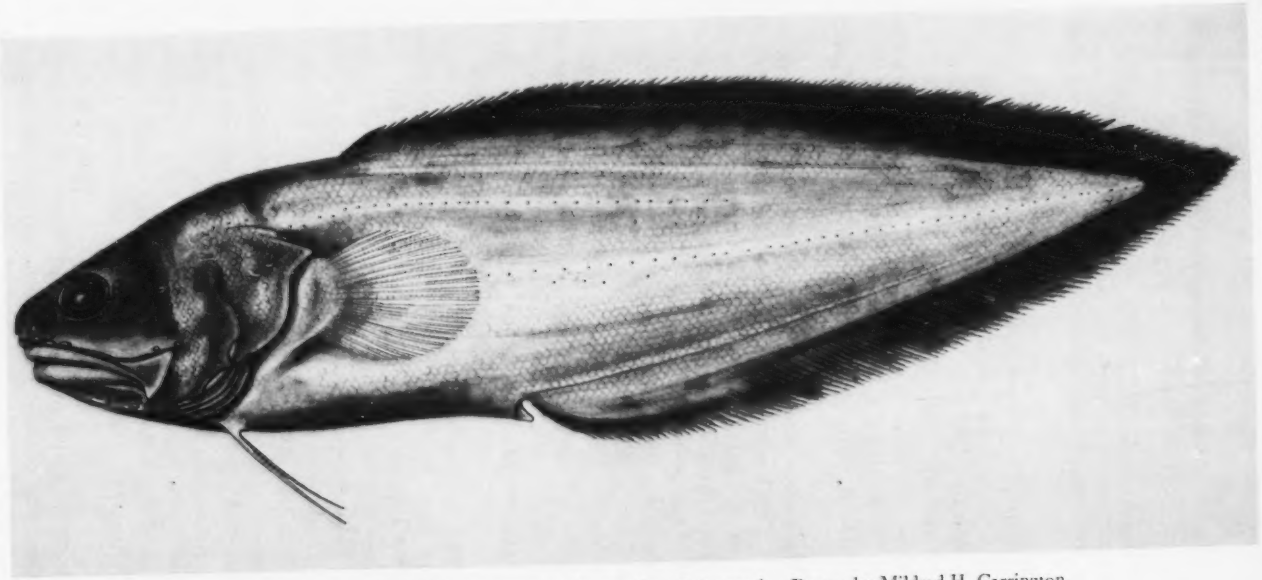


Oligopus longhursti (USNM 187778, holotype. 98 mm. SL. Lagos, Nigeria). Drawn by Mildred H. Carrington.



Oligopus waikiki (USNM 179898, holotype of *Microbrotula nigra*. 61.4 mm. SL. Hawaii). Drawn by Mildred H. Carrington.

Oligopus waikiki (USNM 179898, holotype of *Microbrotula nigra*. 61.4 mm. SL. Hawaii). Drawn by Mildred H. Carrington.



Oligopus diagrammus (SU 7059, paratype. 54 mm. SL. Galapagos). Drawn by Mildred H. Carrington.

Oligopus diagrammus (Heller and Snodgrass)

PLATES 1, 5

Eutyx diagrammus Heller and Snodgrass, 1903, p. 224, pl. 19 (original description, Galapagos, Tagus Cove, Albemarle Island, and Seymour Islands).—Böhlke, 1957, p. 3 (paratype of *E. diagrammus* compared with *Stygnobrotula latebricola*).

STUDY MATERIAL.—Holotype, SU 6346 and paratype SU 7059 from the Galapagos. The following from Guadalupe Island, Baja California, Mexico: SIO 58-497 (1); SIO 58-493 (1); SIO 54-213A (1); SIO 54-219 (1); SIO H53-169 (1); SIO 54-219A (6); SIO 60-14-61E (2). Following from peninsular Baja California or closely adjacent islands: SIO 61-272-61B, Espiritu Santo Island (3); SIO 61-227-61A, Cape San Lucas (2); SIO 61-242-61A (4); and SIO 61-249 (1), Los Frailes.

COUNTS AND MEASUREMENTS.—Caudal 10; vertical scale rows between 100 and 115, very difficult to count. Vertebrae 49–53. (See table 2 for a summary of measurements, and table 3 for counts.)

DESCRIPTION.—Squamation: Patch of scales on top of head posterior to interorbital. Patch of scales present on opercle and in front of opercle extending anteriorly to a point less than eye diameter behind eye. Dorsal and lateral scale patches appearing continuous in some specimens and separated by scaleless area over lateral canal in others (small size of scales and adherent mucous coating on head make this a difficult character of which to be certain). Scale patch posterior to hind margin of maxillary appearing to be continuously connected with main opercular scale patch.

Lateralis system: Lateral canal with 1 pore near upper angle of opercle. Supraorbital canal with 1 pore in front of, and below, anterior nostril. Infraorbital canal with 5 pores: 1 behind anterior nostril; 2 along lip below posterior nostril; and 2 above posterior expanded portion of maxillary. Preoperculomandibular canal with 8 pores: 2 at tip of dentary, 1 opening anteriorly, the other posteriorly; 1 beneath lower lip close to level of posterior nostril (not shown in fig. 4); 1 at about midlength of jaw (could not be found in holotype); 1 slightly ahead of posterior margin of maxillary; 1 slightly behind same. Two elongate slits along posterior margin of preopercle.

Circumorbital, interorbital, and opercular areas and snout bearing scattered papillae. Small dark papillae distributed on head but thickly dispersed in particular on top of head and over adjoining predorsal area of top of body.

Lateral line marked by small papillae. One series of about 30 originating on head above opercle and, after slight irregular dip behind opercle, extending posteriorly in straight line between midline

and dorsal profile. Dorsal line terminating slightly more than halfway back along body. Second line of about 37–45 small papillae originating in midline close to level of posterior tip of pectoral fin, not making pronounced dip at level of vent but extending straight back to tail with, at most, a slight irregularity near its origin.

Dentition: Dentaries with irregular row of sharply pointed teeth along inner margin of bone. Tooth-bearing area of bone broadens on anterior ¼ to ⅓ of lower jaw. In specimens of less than about 100 mm., area exterior to large teeth occupied by granular teeth. In larger specimens these show gradual transition to second row of larger conical teeth that parallels inner row. Also 2 types of dentition on premaxillary. Specimens from 34 mm. to 81 mm. with uniform band of granular teeth, while those measuring 81 mm. and larger bearing row of large conical teeth along outer edge of band of granular teeth. Smaller specimens with only small granular teeth in broadly V-shaped patch on head of vomer. Larger specimens with larger conical teeth as well. Dentition in this species does not appear to be influenced by sex.

Sex: Two types of external sex organs, one consisting of stiff hood projecting posteriorly from vent and folding over genital area, the other consisting of only a low, fleshy ridge in place of prominent hood. In either type a delicate white papilla of varying length may be evident. Neither the two types of external genitalia nor the occurrence of the papilla appears to be correlated with sex as determined by gross observation of the gonads. In addition, at least one specimen (SIO 61–272–61B, Espiritu Santo) and possibly others appear hermaphroditic. What I have interpreted as testicular tissue produces spermatophore-like objects rather than free-running sperm suspensions. If my observations are correct, then sex in this species is a complex problem that requires detailed study.

Head spines: Blunt, flat spine deeply buried in flesh of opercle in most specimens, but exposed in paratype. Ventrally directed maxillary spine prominent in most specimens.

Vertebrae and ribs: Neural spines 5–14 short and broad but becoming progressively more elongate and narrower, their tips truncate; neural spines on subsequent centra needle-like. Centra 7–11 with ribs at ends of parapophyses (although in some, ribs appear to articulate with centrum no. 7); subsequent centra lacking pleural ribs. Centra 4–9 with epipleurals attached to pleural ribs; 10, 13, 14, or 15 with epipleurals associated with parapophyses or haemal spines.

Color: Brown in preservative. In life: "Dark brown, head purplish-brown; fins blackish" (Heller and Snodgrass,1903).

DISTRIBUTION.—Previously known only from the Galapagos at

about 3 fathoms. Here recorded from Guadalupe Island and Baja California.

COMMENTS.—The data on dorsal and anal fin ray counts presented in table 3 indicate that the Galapagos-Guadalupe populations and the Baja California populations of *O. diagrammus* have differentiated. Under ordinary circumstances I would recognize them as named taxa; however, it seems likely that additional populations will be discovered in the tropical eastern Pacific, and this, combined with the puzzling nature of sexuality in this species, makes me hesitant to do more than point out the differences and the problems involved in interpreting them.

Oligopus claudei (Torre)

Benthocometes claudei Torre y Huerta, 1930, opposite p. 171, unnumbered plate (original description, Cuba, Matanzas Bay); 1931?, p. 231, fig. (brief discussion).

Bathystorreus claudei Howell Rivero, 1934, pp. 69–72, pl. 7 (new genus proposed, description).

Grammonus mowbrayi Grey, 1951, p. 154, fig. 1 (original description, type locality, Bermuda).—Collette, 1962, p. 443 (Bahamas).

STUDY MATERIAL.—The holotype of *B. claudei*, MCZ 33943 (in very poor condition). Three specimens ANSP Chaplin Bahama collections, St. 513; about ¼ mile N. of the center of Green Key, Bahamas; taken from inside a small, isolated coral head at a depth of 50 feet. One specimen, UP 1150; Puerto Rico, La Parquera, 6 miles offshore at vertical ledge, 65 feet. One specimen, UP 1151, Curaçao, cave at shore, about 100 meters SE. of entrance to bay.

COUNTS AND MEASUREMENTS.—See table 4.

DESCRIPTION.—Squamation: Scales present in patch over nape, on side of head over opercle and cheek, extending forward to a point less than eye diameter behind eye and ventrally to patch behind posterior margin of maxillary.

Lateralis system: Lateral canal with 4 pores in row: the most posterior above upper angle of opercle; the most anterior at junction of lateral canal and infraorbital canal. Supraorbital canal in Bahaman specimens with 4 pores extending in straight line from most anterior in front of anterior nostril to most posterior over rear half of eye; Puerto Rican specimen with only the 2 most anterior pores; and Curaçao specimen with the 3 most anterior pores on one side and the 2 most anterior pores on other side. Infraorbital canal with 8, 9, or 10 pores: 3 beneath nostrils; 1 smaller pore beneath eye about midway between orbit and lip; 2 or 3 pores in skin along maxillary sheath; and 2 or 3 pores in row extending up to lateral canal. Preoperculomandibular canal with 9–11 pores: 2 at tip of dentary, 1 opening anteriorly, the other posteriorly; 1 beneath lower lip at level of anterior margin of eye; row of 3

pores along medial edge of dentary, anteriormost about ⅓ of distance along pore, posterior beneath end of maxillary: 1 small pore sometimes present lateral to middle pore of this series; 1 pore above angular; 2 on posterior margin of preopercle, and sometimes another above, and in front of, dorsalmost preopercular pore. The pore system is well illustrated in the figure given with the original description of this species (Torre y Huerta, 1930). One difference is that the Bahaman material lacks the pore on the posterior surface of the angular, as shown on the holotype.

Lateral line system along body variable and complex, consisting basically of 2 rows of papillae: one with about 35 papillae originating over opercle and extending posteriorly almost to tail in line between midline of fish and dorsal profile; the other, with about 25 papillae, beginning slightly ahead of level of vent and, after an irregular beginning, proceeding posteriorly almost to tail in straight line between midline of fish and ventral profile of fish. In addition to these 2 basic lines (illustrated on the figure of the holotype), there are a profusion of other papillae whose distribution will not be described in detail. Suffice it to say that some are distributed virtually at random, some are in short series above or below the main lines, some are in short rows in the midline of the fish.

Papillae also scattered about on head, as are very small dermal filaments; however, no rugose areas on head.

Dentition and sex: In two specimens a band of granular teeth on premaxillary, another on dentary. Head of vomer carrying 2 large bony knobs, each with patch of granular teeth, each patch connected by narrow line of short teeth. Three other specimens with bands of granular teeth noted above and, in addition, with irregular single row of larger conical teeth located lateral to granular row on premaxillaries and medial to granular row on dentaries. A few of vomerine teeth also slightly enlarged. Specimens with granular teeth with only a small, fleshy flap over genital area. Other 3 with prominent, stiffened hoods; at least 1, UP 1151, with well-developed testes.

Head spines: Short, sharp spine piercing skin at upper angle of opercle. One specimen with several short spines at lower angle of opercle. Two short, sharp spines at lower angle of preopercle. Ventrally projecting premaxillary spine prominent, angular projecting downward as prominent blunt spine.

Vertebrae and ribs: Neural spines 5–13 or 14 short and broad but becoming progressively more elongate and narrower; their tips truncate. Neural spines on subsequent centra needle-like. Centrum 7 with free ribs, although rudiments of parapophysis visible on X-ray photograph of 1 specimen. Centra 8, 9, and 10–12 with ribs at ends of parapophyses, subsequent centra lacking pleural ribs. Centra

4–8 with epipleurals attached to pleural ribs; on centra 9–13 or 14, epipleurals associated with parapophyses or haemal spines.

Color: Body light brown; vertical fins dark, particularly on their vertical margins.

DISTRIBUTION.—Bermuda, the Bahamas, Puerto Rico, and Curaçao.

COMMENTS.—The holotype of *O. claudei* is in such poor condition that accurate measurements are impossible, and observations on the lateralis system are subject to question. It does seem certain, however, that, with the material at hand, there is no way of maintaining *Grammonus mowbrayi* Grey as a valid species.

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TABLE 1.—*Counts and measurements of* Oligopus longhursti

Counts	Holotype USNM 187778		Paratype USNM 187779		Paratype USNM 191732		Paratype USNM 191732		Paratype USNM 193678	
Dorsal	88		89		83		85		86	
Anal	58		61		58		61		59	
Pectoral	25		24		25		25		25	
Vertebrae	45		44		45		45		44	
Caudal	8		8		8		8		8	
Vertical scale rows (approximately)	120		–		120		120		120	
Measurements	**mm.**	**%SL**	**mm.**	**%SL**	**mm.**	**%SL**	**mm.**	**%SL**	**mm.**	**%SL**
Standard length	98.0	–	92.6	–	105	–	105	–	106	–
Body depth at dorsal origin	27.0	27.5	23.5	25.4	25.0	23.8	–	–	–	–
Predorsal	30.0	30.6	29.5	31.9	31.4	29.9	32.5	30.7	33.5	31.6
Preanal	50.5	51.5	48.5	52.4	55.1	52.5	58.0	54.7	60.4	56.9
Head length	25.6	26.1	24.3	26.2	26.2	24.9	26.9	25.4	28.5	26.7
Snout	5.9	6.0	5.7	6.2	6.2	5.9	5.2	4.5	6.2	5.8
Orbit	4.5	4.6	3.5	3.8	3.5	3.3	4.2	4.0	4.0	3.8
Upper jaw	15.0	15.3	14.0	15.1	14.8	14.1	14.5	13.7	15.5	14.6
Greatest width of maxillary	5.4	5.5	5.0	5.4	4.7	4.5	4.2	4.0	4.2	4.0
Greatest width of head	15.0	15.3	13.0	14.0	16.0	15.2	16.1	15.2	–	–

TABLE 2.—*Summary of measurements on* O. diagrammus *from three geographical localities (given as percent of standard length; average in parenthesis followed by range)*

Measurement	Galapagos-N=2[1]	Guadalupe-N=13	Peninsular Baja Calif.-N=8
Range in standard length (mm.)	91, 54	74.7–184	34.5–81.0
Depth at dorsal origin	23.6 (21.4, 25.9)	24.5 [2] (21.3–32.1)	23.1 (20.9–25.2)
Predorsal	29.5 (28.6, 30.4)	29.1 (26.3–30.9)	29.4 (26.3–31.9)
Preanal	44.1 (43.9, 44.4)	47.3 (46.3–51.3)	46.3 (43.8–48.1)
Head length	26.6 (25.5, 27.8)	26.0 (25.1–27.2)	26.9 (25.3–27.8)
Snout	5.9 (5.4, 6.5)	5.2 (4.6–6.2)	5.7 (4.9–6.6)
Orbit	5.0 (4.4, 5.6)	4.3 (3.8–4.7)	4.8 (4.7–6.1)
Upper jaw	13.8 (14.7, 13.0)	13.2 (12.5–13.8)	13.7 (12.8–14.4)
Maxillary width	4.35 (4.3, 4.4)	4.4 (3.9–4.7)	4.5 [3] (4.0–5.0)
Head width	14.9 (13.4, 16.5)	14.2 (12.0–17.7)	13.3 (11.1–17.3)

[1] First number in parenthesis is holotype, second is paratype.
[2] N=12.
[3] N=5.

TABLE 3.—*Meristic data for* O. diagrammus *from three geographical localities*

Locality	Dorsal fin rays																				
	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115
Galapagos	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–
Guadalupe	–	–	–	–	–	–	–	–	–	1	1	–	1	–	–	–	2	3	1	1	1
Baja California	2	–	–	–	3	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–

Locality	Anal fin rays																				
	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91					
Galapagos	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–					
Guadalupe	–	–	–	–	1	1	1	1	2	2	1	2	–	–	–	1					
Baja California	1	4	–	2	–	–	–	–	–	–	–	–	–	–	–	–					

Locality	Pectoral fin rays					
	24	25	26	27	28	29
Galapagos	–	–	–	–	1	1
Guadalupe	–	–	6	4	1	–
Baja California	1	1	1	4	–	–

TABLE 4.—*Counts and measurements of* Oligopus claudei

Counts	Holotype MCZ 33943		3 specimens from Chaplin Bahama coll. sta. 513						Puerto Rico UP 1150		Curaçao UP 1151	
Dorsal fin rays	88		87		86		85		85		82	
Anal fin rays	[1]62		66		67		69		68		64	
Pectoral fin rays	25		24		24		25		23		23	
Vertebrae	43		43		43		43		42		41	
Caudal fin rays	–		10		10		10		10		10	
Vertical scale rows (approx.)	75+		80		79		–		–		75	
Measurements	**mm.**	**%SL**	**mm.**	**%SL**	**mm.**	**%SL**	**mm.**	**%SL**	**mm.**	**%SL**	**mm.**	**%SL**
Standard length	90	(approx.)	79.1	–	80.6	–	80.6	–	45.0	–	58.4	–
Body depth at dorsal origin	–	–	–	–	22.2	27.5	23.0	28.5	12.0	26.7	15.6	26.7
Predorsal	–	–	29.1	36.8	28.7	35.6	27.4	34.0	14.5	32.2	19.5	33.4
Preanal	–	–	41.2	52.1	41.8	51.9	41.0	50.9	20.7	46.0	27.9	47.8
Head length	–	–	23.2	29.3	25.3	31.4	25.1	31.1	13.0	28.9	17.1	29.3
Snout	–	–	5.2	6.6	6.2	7.7	6.3	7.8	2.1	6.9	3.9	6.7
Orbit	–	–	3.6	4.6	4.0	5.0	3.8	4.7	2.7	6.0	2.6	4.4
Upper jaw	–	–	13.0	16.4	13.4	16.6	14.0	17.4	7.2	16.0	9.9	16.9
Greatest width at maxillary	–	–	5.0	6.3	5.2	6.4	5.4	6.7	3.0	6.7	4.0	6.9
Greatest width of head	–	–	15.0	19.0	15.1	18.7	15.4	19.1	7.6	16.9	8.7	14.9

[1] Possibly several more.

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NORTH AMERICAN STENOMIDAE (LEPIDOPTERA: GELECHIOIDEA)

By W. DONALD DUCKWORTH

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NORTH AMERICAN STENOMIDAE (LEPIDOPTERA: GELECHIOIDEA)

By W. Donald Duckworth

Introduction

This is a review of the North American moths of the family Stenomidae, a large family of Microlepidoptera that is especially abundant in Central and South America, where it is represented by hundreds of species of remarkable diversity in size, shape, and color. In North America the family is represented by 24 species in 6 genera, widely distributed throughout the United States and parts of Canada.

Formerly, identification of species in the Stenomidae rested almost solely on coloration and, to a lesser extent, on wing venation. Higher categories, for the most part, were based on wing venation. In recent years, it has been discovered that genitalic characters in the Stenomidae, as in other groups of Lepidoptera, are of value in the separation and definition of closely related species. It seems obvious that the genitalia, in addition to their usefulness in identifying species, have a place of primary importance in characterizing genera. The present study also indicates that the genitalia provide valuable characters for classification at family level.

Busck (1921a) recognized the value of genital characters to higher category concepts and transferred the genus *Setiostoma* Zeller from

Glyphipterygidae to Stenomidae after a careful study of their structures. He also indicated that on the basis of the genitalia, the Stenomidae and Xylorcytidae should be recognized as separate families.

The failure of other workers to accept the evidence available from studies of the genitalia led to controversy and confusion. Meyrick admitted the value of the genitalia as an aid to classification but based his higher categories primarily on wing venation and other characters.

Although the author is convinced that the genitalia are of primary importance in the problems of delimiting higher categories in the Stenomidae, an attempt to solve these problems without first making a detailed study of the Central and South American species would be unrealistic. A generic classification of stenomids is being undertaken presently as a separate study.

The following classification uses structures of both male and female genitalia, as well as color and other adult characteristics. Illustrations of the genitalia of both sexes are given for each species. The terminology used for structures of the male and female genitalia of Lepidoptera is very extensive and complex. Despite this, there is a constant application of new names, as well as misapplication of old ones, by taxonomists who need names for many structures with doubtful homologies. Some workers apply the same name to structures similar in appearance, even in widely separated families, while others hesitate to apply the same name to two structures unless these have been shown to be strictly homologous. The majority of workers do not wish to contribute to further instability of nomenclature but are unable to await the results of morphological studies dealing with the homologies. The nomenclature of the genitalia in this paper follows the recommendations made by Klots in Tuxen's publication (1956) on insect genitalia.

Biological studies and larval host plant records for North American stenomids are few; known records for each species are listed in the text. The larvae of the North American species feed chiefly on trees and shrubs such as oak, maple, and laurel, although one species, *Stenoma mistrella* Busck, has been found on timothy (*Phleum pratense* L.). Exotic species are known to feed on avocado, custard apple (*Annona* sp.), coffee, and cacao.

The literature on the North American species of Stenomidae is somewhat confused because of the uncertainty of many authors as to the relationship of Stenomidae to other closely related families. Much of this uncertainty has come from Edward Meyrick's work (1880, 1889, 1890, 1913, 1915, 1922, 1925, 1928, 1929) in the Stenomidae and related groups.

As mentioned earlier, Meyrick's system of classification was based primarily on wing venation. He also tried to employ a hypothesis, based on a mathematical formula, to provide a convenient artificial system to which he could fit his classification. The desired standard in Meyrick's classification was an average of about 10 species to the genus and 50 genera to the family in the world fauna. His failure to accept classification based on other valuable structures, such as the genitalia, left many unanswered questions concerning relationships of categories within the Stenomidae and relationships of this family to other families.

The relationship between Stenomidae and Xyloryctidae has presented a difficult problem; Busck (1921a) transferred the genus *Setiostoma* Zeller from Glyphipterygidae to Stenomidae. Forbes (1923) evidently felt the two families were not distinct because he listed them as subfamilies under the family Xyloryctidae. Clarke (1955a) recognized them as separate families: the Xyloryctidae being confined principally to the Old World and the Stenomidae to the New World.

The genus *Stenoma* Zeller, upon which the family is based, is still a doubtful entity. The type species, *Stenoma litura* Zeller, is based on a single female now in the British Museum that, according to Clarke (1955a), is unlike any of the approximately 600 species that have been placed as congeners. Clarke (1955a) also states that this great mass of species is still a heterogeneity that will require close study, with the possible delimitation of many new genera based on diagnostic refinements.

Some genera that have been considered to be doubtful with respect to family affinity are herein treated as Stenomidae on the basis of the genitalia, pending a more comprehensive study of generic relationships throughout the family. In this paper, the family Stenomidae in North America includes the genera *Stenoma*, *Antaeotricha*, *Setiostoma*, *Mothonica*, *Menestomorpha*, and *Menesta*. The genus *Menesta* was moved by Forbes (1923) from the family Gelechiidae to the Stenomidae on the basis of the genitalia, as well as other adult and pupal characters.

The author gratefully acknowledges the aid of Dr. David A. Young of North Carolina State College, who encouraged the undertaking of a taxonomic problem in the Microlepidoptera and made suggestions on the preparation of this paper. Sincere thanks are also due Dr. J. F. Gates Clarke, Head Curator of Entomology, U.S. National Museum, for suggesting this problem, for technical advice, and for his kind encouragement. The loan of material from their respective private collections by Mr. C. P. Kimball and by Dr. Ronald Hodges also is gratefully acknowledged. The author also wishes to thank

Mr. André Pizzini for the distribution maps and Mr. Jack Scott for the photographic work.

Family Stenomidae Meyrick

Stenomidae Meyrick (in part), 1906, Trans. Roy. Soc. South Australia, vol. 30, p. 50; 1909, Trans. Ent. Soc. London, p. 28; 1912, Trans. Ent. Soc. London, p. 706; 1931, Anal. Mus. Nac. Hist. Nat. Buenos Aires, vol. 36, p. 378.—Walsingham, 1912, Lepidoptera-Heterocera, vol. 4 (vol. 42 *in* Godman and Salvin, Biologia Centrali-Americana), pp. 153–187; 1913, Lepidoptera-Heterocera, vol. 4 (vol. 42 *in* Godman and Salvin, Biologia Centrali-Americana), pp. 188–190.—Barnes and Busck, 1920, Contrib. Nat. Hist. Lepidop. North America, vol. 4, p. 236.

Stenomatidae Walsingham, 1907, Proc. U.S. Nat. Mus., vol. 33, p. 214.

Cryptolechiidae Meyrick (in part), 1883, Trans. Ent. Soc. London, p. 124.

Xyloryctidae Meyrick (in part), 1925–1934, Exotic Microlepidoptera, vols. 1-4.—Forbes, 1923, Cornell Agric. Exp. Sta. Mem., vol. 68, p. 250.

Cryptophasidae Fletcher (in part), 1929, Mem. Dept. Agric. India, Ent. Ser., vol. 11, pp. 1–244.

Stenomides Meyrick, 1930, Ann. Naturhist. Mus. Wien, vol. 44, p. 233.

Stenominae Janse, 1932, The moths of South Africa, vol. 1, p. 61.

Type genus.—*Stenoma* Zeller.

Male antenna heavily ciliated ventrally, female with slight or no ciliation, basal segment without pecten; labial palpus compressed, curved gradually dorsad and extending above crown of head. Forewing with 12 veins (or 11 by fusion of veins 2 and 3); vein 1b furcate at base; vein 7 separate to termen, apex or costa; veins 2–3 and 4 separate, connate, or stalked; veins 2 and 3 fused, stalked, or separate. Forewing typically much more than twice as long as wide; shorter in *Menesta* and *Setiostoma*. Hindwing with veins 6 and 7 stalked; 3 and 4 connate, stalked, or fused; vein 5 close to, connate, or fused with 4; typically very broad with rounded termen.

Male genitalia: Symmetrical; harpes simple or divided into lobes, bearing bifurcate setae that may be long and straight, long and recurved, or short; socii and transtilla absent; anellus a simple plate or with moderately or well-developed lateral processes. Vinculum band-like, complete or incomplete. Gnathos present; uncus present, well developed or reduced.

Female genitalia: Genital plate variously sclerotized or membranous; corpus bursae with or without signum.

Key to Species of North American Stenomidae Based on Genitalia

1. Male 2
   Female 24
2. Harpes with thumblike projection on costa bearing long, recurved, bifurcate setae . . . . . (Genus *Antaeotricha* Zeller) 3
   Harpes without such a projection 17

3. Anellus with lateral lobes 4
Anellus without lateral lobes 15
4. Anellus with two lateral lobes 5
Anellus with four lateral lobes 11
5. Tip of gnathos broad, notched 6
Tip of gnathos narrow, unnotched 7
6. Left lobe of anellus forked . . . . . 1. **Antaeotricha schlaegeri** (Zeller)
Left lobe of anellus simple . . 2. **Antaeotricha lindseyi** (Barnes and Busck)
7. Uncus simple; lobes of anellus small, bearing setae at tips; cornuti a long mass of small spines . . . . . 8. **Antaeotricha irene** (Barnes and Busck)
Uncus not simple; combination of characters not as above 8
8. Aedeagus with cornuti; combination of characters not as below 9
Aedeagus without cornuti; uncus with dilated tip; lateral lobes of anellus upright, sharply pointed . . . 11. **Antaeotricha haesitans** (Walsingham)
9. Vinculum produced into dorsally projecting process in front.
13. **Antaeotricha fuscorectangulata,** new species
Vinculum not produced into dorsally projecting process 10
10. Uncus with broadened tip; aedeagus flaring apically.
4. **Antaeotricha leucillana** (Zeller)
Uncus with tip terminating in two short spines; aedeagus short, broad, truncate at tip . . . . . 15. **Antaeotricha manzanitae** Keifer
11. Uncus distinctly notched at tip, aedeagus with cornuti a large irregular group of very small spines; with lateral recurved process.
7. **Antaeotricha furcata** (Walsingham)
Uncus without notched tip, aedeagus without cornuti and without lateral recurved process 12
12. Gnathos divided into two lobes at tip 13
Gnathos not divided into two lobes at tip 14
13. Lobes on tip of gnathos blunt . . 3. **Antaeotricha unipunctella** (Clemens)
Lobes on tip of gnathos acuminate.
14. **Antaeotricha vestalis** (Barnes and Busck)
14. Lobes of anellus unequal, dorsal lobe large, laterally curved, with dense, brushlike group of spines on inner margin of apical third; ventral lobes reduced, setiferous; aedeagus without spine.
6. **Antaeotricha decorosella** (Busck)
Lobes of anellus approximately equal in size, dorsal ones with heavy spines at tip, ventral ones setiferous; aedeagus with apical spine.
5. **Antaeotricha osseella** (Walsingham)
15. Anellus V-shaped, uncus dilated at tip, not cleft.
9. **Antaeotricha humilis** (Zeller)
Anellus not V-shaped, uncus not dilated at tip 16
16. Uncus attenuate, cleft at tip.
11. **Antaeotricha thomasi** (Barnes and Busck)
Uncus truncate, not cleft at tip . . 10. **Antaeotricha agrioschista** (Meyrick)
17. Harpes simple with palmate, multilobed setae on outer part of costa.
(Genus *Setiostoma* Zeller) 18
Harpes simple or compound without palmate, multilobed setae on outer part of costa 19
18. Cornuti consisting of more than one large single spine.
2. **Setiostoma fernaldella** Riley
Cornuti consisting of one large single spine.
1. **Setiostoma xanthobasis** Zeller

19. Harpes compound 20
Harpes simple 21
20. Sacculus with prominent bifurcate lobe.
(Genus *Mothonica* Walsingham) 1. **Mothonica kimballi,** new species
Sacculus a large fleshy lobe . . (Genus *Menestomorpha* Walsingham)
1. **Menestomorpha oblongata** (Walsingham)
21. Uncus reduced . . . . . (Genus *Stenoma* Zeller) 22
Uncus large, tapering, curved ventrad, lying parallel to gnathos.
(Genus *Menesta* Clemens) 23
22. Aedeagus large, flared apically; cornuti two clusters of very heavy spines.
1. **Stenoma mistrella** Busck
Aedeagus small, broad; cornuti one small cluster of heavy spines.
2. **Stenoma crambitella** Walsingham
23. Cornuti consisting of two heavy spines.
1. **Menesta tortriciformella** Clemens
Cornuti consisting of one heavy spine. . . 2. **Menesta melanella** Murtfeldt
24. Anterior apophyses fused to genital plate or very reduced.
(Genus *Antaeotricha* Zeller) 25
Anterior apophyses free, well developed 37
25. Corpus bursae with signum 28
Corpus bursae without signum 26
26. Corpus bursae corrugated, genital plate bandlike.
15. **Antaeotricha manzanitae** Keifer
Corpus bursae not corrugated, genital plate not bandlike 27
27. Genital plate reduced, lamella antevaginalis and postvaginalis not differentiated, ductus bursae short, sclerotized, corpus bursae small.
4. **Antaeotricha leucillana** (Zeller)
Genital plate well developed, lamella antevaginalis small, forming triangular flap over ostium . . . . . 12. **Antaeotricha haesitans** (Walsingham)
28. Genital plate reduced to simple band, signum with single large spine . . 29
Genital plate more complex, signum a small- to large-toothed plate . . 32
29. Anterior apophyses fused to genital plate.
11. **Antaeotricha thomasi** (Barnes and Busck)
Anterior apophyses small, not fused to genital plate 30
30. Ostium bursae with a pouchlike evagination between ostium and inception of ductus seminalis . . 13. **Antaeotricha fuscorectangulata,** new species
Ostium bursae without such an opening 31
31. Genital plate excavated along posterior margin, ductus bursae short.
10. **Antaeotricha agrioschista** (Meyrick)
Genital plate not excavated, ductus bursae long.
9. **Antaeotricha humilis** (Zeller)
32. Ostium opening near center of genital plate 33
Ostium opening near anterior margin of genital plate 36
33. Ductus bursae sclerotized from midpoint to corpus bursae
8. **Antaeotricha irene** (Barnes and Busck)
Ductus bursae not sclerotized 34
34. Posterior margin of genital plate cleft medially.
5. **Antaeotricha osseella** (Walsingham)
Posterior margin of genital plate not cleft 35
35. Genital plate with median T-shaped process extending over ostium.
3. **Antaeotricha unipunctella** (Clemens)
Genital plate without process . . . . . 14. **Antaeotricha vestalis** (Zeller)

36. Genital plate with large, median, elevated area directly posterior to ostium 37
Genital plate without such an area . . 6. **Antaeotricha decorosella** (Busck)
37. Ductus bursae thick, short, approximately same length as corpus bursae.
7. **Antaeotricha furcata** (Walsingham)
Ductus bursae slender, long, approximately twice length of corpus bursae.
1. **Antaeotricha schlaegeri** (Zeller)
or 2. **Antaeotricha lindseyi** (Barnesand Busck)
38. Genital plate membraneous . . . . . (Genus *Setiostoma* Zeller) 39
Genital plate not membraneous 40
39. Corpus bursae with signum . . . . . 1. **Setiostoma xanthobasis** Zeller
Corpus bursae without signum . . . . . 2. **Setiostoma fernaldella** Riley
40. Genital plate fused to eighth sternum . . . . . (Genus *Stenoma* Zeller) 41
Genital plate not fused to eighth sternum. 42
41. Corpus bursae with one lightly sclerotized signum.
1. **Stenoma mistrella** Busck
Corpus bursae with two lightly sclerotized, dentate signa.
2. **Stenoma crambitella** Walsingham
42. Signum large, dumbbell-shaped, dentate.
1. **Mothonica kimballi,** new species
Signum not as above 43
43. Genital plate reduced to small, median, triangular sclerite.
(Genus *Menesta* Clemens) 44
Genital plate reduced to simple liplike band surrounding ostium.
1. **Menestomorpha oblongata** Walsingham
44. Corpus bursae with heavily sclerotized, cross-shaped signum with median projecting lobe . . . . . 1. **Menesta tortriciformella** Clemens
Corpus bursae with heavily sclerotized, rectangular signum with median projecting lobe . . . . . 2. **Menesta melanella** Murtfeldt

Genus *Antaeotricha* Zeller

Antaeotricha Zeller, 1854, Linn. Entom., vol. 9, p. 390.

1. *Antaeotricha schlaegeri* (Zeller)

FIGURES 1, 24; PLATE 1a; MAP 1

Cryptolechia schlaegeri Zeller, 1854, Linn. Entom., vol. 9, p. 372; 1855, Linn. Entom., vol. 10, p. 158; 1873, Verh. Zool.-Bot. Ges. Wien, vol. 23, p. 246.
Stenoma schlaegeri Walsingham, 1889, Insect Life, vol. 2, p. 152.—Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.—Forbes, 1923, Cornell Agric. Exp. Sta. Mem., vol. 68, p. 252.
Antaeotricha schlaegeri Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 28.

Alar expanse 21–27 mm.

Color: Face white; palpus white, sprinkled with dusky scales. Legs white; foreleg smoky; midleg with dark tarsi ringed with light scales. Thorax white dorsally with brownish-black tuft posteriorly. Abdomen white. Forewings white, basal half with conspicuous, mixed light and dark brown, somewhat raised patch of scales on hindmargin from basal angle almost to middle of wing, apical half with irregular discal area of dusky scales; postmedial and

subterminal bands broad, even; dusky terminal band very narrow, cut into spots; black line, usually broken, in base of cilia. Hindwing very pale tan with white cilia.

Male genitalia: Uncus simple, curved ventrad; gnathos very broad, broadly notched at tip; harpes each with costa bearing a thumblike projection with long, recurved, bifurcate setae; vinculum complete; anellus with two large, upright lateral lobes, one forked, the other simple; aedeagus with apex acute, cornuti absent.

Female genitalia: Genital plate large, lamella antevaginalis a small, semicircular plate; lamella postvaginalis larger, with median elevated area; ostium bursae and ductus bursae membranous; corpus bursae with signum large, dentate; inception of ductus seminalis near ostium. Anterior apophyses fused to genital plate.

Type: In the British Museum (Natural History).

Type locality: New York.

Food plant: *Quercus alba* L.

Distribution: QUEBEC: Meach Lake (May, June). NEW YORK: Allegany State Park (June, July, Aug.); Flatbush (June); Ilion (June). MASSACHUSETTS: Martha's Vineyard (June); Vineyard Haven (June). PENNSYLVANIA: Beaver Co. (May); New Brighton (May, June); Pittsburgh (May). NEW JERSEY: Essex Co. Park (May, June). DELAWARE: New Castle (June). MARYLAND: Plummers Island (May); Riverdale (June). DISTRICT OF COLUMBIA: Washington (June). VIRGINIA: Falls Church (May, Aug.); Grange Camp (May). NORTH CAROLINA: Raleigh (April, June, Aug.). ARKANSAS: Oracle (July). MISSOURI: St. Louis (June). ILLINOIS: Quincy (May); Decatur (May). IOWA: Iowa City (June); Sioux City (May); Homestead (May). TEXAS: Waco (May); Dallas. ARIZONA: Huachuca Mts. (Oct.); Palmerlee; Oracle (July).

This species is very similar to *Antaeotricha lindseyi*. Possibly the two are conspecific, but until series of *A. lindseyi* can be obtained and the variation studied, I prefer to recognize them as distinct species. They may be distinguised by differences in the shapes of the aedeagus and of one of the anellar lobes. Significant differences in the female genitalia have not been found.

2. *Antaeotricha lindseyi* (Barnes and Busck)

FIGURE 2; PLATE 1b; MAP 1

Stenoma lindseyi Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 239.

Antaeotricha lindseyi Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 25.

Alar expanse 25–28 mm.

Color: Face, palpus, and legs white. Thorax white dorsally with brown tuft of scales posteriorly. Abdomen white. Forewing longer,

narrower, and more pointed than in *A. schlaegeri*, and with dark area on hindmargin (which is interrupted near middle of forewing in *A. schlaegeri*) continued to anal angle. Hindwing of male dark brownish, considerably darker than those of *A. schlaegeri*.

Male genitalia: As in *A. schlaegeri*, except anellar lobe hooked instead of forked, and aedeagus shaped differently.

Female genitalia: As in *A. schlaegeri*.

Type: In the United States National Museum.

Type locality: Paradise, Cochise County, Arizona.

Food plant: Unknown.

Distribution: ARIZONA: Prescott (Sept.); Paradise, Cochise Co. (July, Sept.); Gila Co. (June); Palmerlee; Yavapai Co. (Sept.); (Huachuca Mts.; Baboquivarii Mts. (July); Mohave Co. (Sept.); Dewey; Redington. NEW MEXICO: Rincon (June); Ft. Wingate (June).

This species is closely related to *A. schlaegeri;* the distinguishing characters have been noted under that species.

3. *Antaeotricha unipunctella* (Clemens)

FIGURES 3, 25; PLATE 1c; MAP 2

Brachiloma unipunctella Clemens, 1863, Proc. Ent. Soc. Philadelphia, vol. 2, p. 126; 1872, The Tineina of North America, p. 232.—Busck, 1903a, Proc. Ent. Soc. Washington, vol. 5, p. 214.

Cryptolechia lithosina Zeller, 1873, Verh. Zool.-Bot. Ges. Wien, vol. 23, p. 244.

Harpalyce tortricella Chambers, 1874, Canadian Ent., vol. 6, p. 235.

Ide tortricella Chambers, 1877, Bull. U.S. Geol. Surv., vol. 3, p. 122, 141.

Ide lithosina Walsingham, 1889, Insect Life, vol. 2, p. 155.

Stenoma unipunctella Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.—Forbes, 1923, Cornell Agric. Exp. Sta. Mem., vol. 68, p. 253.

Antaeotricha unipunctella Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 30.

Alar expanse 20–22 mm.

Color: Face and palpus white. Foreleg brownish; mid- and hindleg white. Thorax stramineous dorsally. Forewing stramineous; discal cell with or without one or two brownish dots apically. Hindwing white.

Male genitalia: Uncus a long, narrow stem beyond dilated base, arched and spatulate at apex. Gnathos broad, divided into two rounded lobes at tip; harpes as in *A. schlaegeri;* vinculum complete, arching in front; anellus with four lateral lobes, two on each side of aedeagus, hindlobes longer and with heavy spines apically; aedeagus dilated at base, tapering to smoothly rounded tip, cornuti absent.

Female genitalia: Genital plate wide, short; ostium bursae sclerotized; ductus bursae membranous; corpus bursae with signum large, dentate; inception of ductus seminalis near ostium.

Type: In Academy of Natural Sciences of Philadelphia.

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Type locality: Pennsylvania (*B. unipunctella*), Texas (*C. lithosina*, *H. tortricella*).

Food plant: *Quercus* sp. In the USNM collection there is one specimen that has been reared from chestnut.

Distribution: FLORIDA: Fort Myers (April); Cocoanut Grove; St. Petersburg (Oct.); Enterprise (May); Hastings (Sept.); Oneco (May); Weeki Wachee Springs (May); Sarasota (May). LOUISIANA: Natchitoches Parish (Aug.). TEXAS: Kerrville (April, May, June, Aug.); Burnett Co. (Sept., Oct.); Belfrage; Shovel Mt. (July). ARIZONA: Yavapai Co.; Ft. Grant (July).

This species is very similar to *A. decorosella* in both coloration and genitalia; however, the forewings are stramineous in color, the male genitalia have a much larger and more broadly notched gnathos, the aedeagus is shaped differently, and the female genital opening is in the center of the genital plate rather than on the anterior edge.

4. *Antaeotricha leucillana* (Zeller)

FIGURES 4, 26; PLATE 1d; MAP 3

Cryptolechia leucillana Zeller, 1854, Linn. Entom., vol. 9, p. 370.
Cryptolechia algidella Walker, 1864, List of the specimens of lepidopterous insects in the collection of the British Museum, vol. 29, p. 710. (New synonymy.)
Stenoma leucillana Walsingham, 1889, Insect Life, vol. 2, p. 153.
Stenoma algidella Walsingham, 1889, Insect Life, vol. 2, p. 153.—Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.
Antaeotricha leucillana Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 25.

Alar expanse 15–23 mm.

Color: Face and palpus white, sprinkled with brown. Legs white; forelegs covered with dark scales. Thorax white dorsally with brownish black tuft posteriorly as in *A. schlaegeri* but former with brown cilia on apical half.

Male genitalia: Uncus with broadened, bifid tip; gnathos simple, slender, ending in a kind of beak; harpes as in *A. schlaegeri*, vinculum complete, anellus with two rounded, lateral lobes; aedeagus large, flaring apically with ventral half extending farther than dorsal and forming a broad lip; cornuti a cluster of many medium-sized spines.

Female genitalia: Genital plate reduced to simple band; ostium bursae and ductus bursae short, sclerotized; corpus bursae small; signum absent; inception of ductus seminalis near ostium.

Type: Unknown.

Type locality: Georgia (*C. leucillana*), Nova Scotia (*C. algidella*).

Food plants: *Pyracantha crenulata* (Roxb.), *Malus* sp., *Vaccinium corymbosum* L., *Acer* sp. Frost (1931) gives an account of the life history of *S. algidella* (= *A. leucillana*).

Distribution: NEW HAMPSHIRE: Hampton (June, July); White Mts. MASSACHUSETTS: Martha's Vineyard (July). NEW YORK:

Orient (Aug., Sept., Oct.); McLean Bogs Reserve (May, June); Ithaca (May, June, Aug.); Boreas River, Essex Co. (July); Mattituck (June); Trenton Falls (June); Rock City (June); West Falls (Aug.); Buffalo (July); E. Aurora (May, June); Horseheads (May); Monroe Co. (June). PENNSYLVANIA: South Gibson (Aug.); Oak Station (May, July); New Brighton (April, May, June); Pittsburgh (May, Aug.); Beaver Co. (May). NEW JERSEY: Reach (Aug.); Anglesea (May); Park (Aug.); Whitesbog (May, Oct.); Oakland (Aug.); New Lisbon (July). MARYLAND: Plummers Island (June, Aug.); Hyattsville (May); Cabin John (June). DISTRICT OF COLUMBIA: Washington (May, June). VIRGINIA: Shenandoah (Aug.); Stafford (May). WEST VIRGINIA: White Sulphur Springs (July). NORTH CAROLINA: Tryon (May); Southern Pines (July, Aug.); White Lake (July). SOUTH CAROLINA: Oconee (Aug.). FLORIDA: Gainesville (July); St. Petersburg (Jan.); Vero Beach (Feb., March, Oct., Nov.); Oneco (June); Weeki Wachee Springs (June); Siesta Key (May, June); Bradenton (Aug.); Pensacola (March). GEORGIA: Savannah (July). ALABAMA: Camp Rucker (April); Flatwood (June); Leroy (June). MISSISSIPPI: Biloxi (June); Ocean Springs (April); Bolton (Aug.). ARKANSAS: Sulphur City (Aug.). MISSOURI: Mountain Grove (July). KANSAS: Lawrence (April, May). ILLINOIS: Decatur (March, April, May). IOWA: Iowa City (July); Sioux City (June, July); Homestead (May). OHIO: Cuyahoga Co. (May); Dayton (May). MANITOBA: Cartwright. TEXAS: Denver (June); Brownsville (June); San Benito (Aug.); Kerrville (June); Tiger Mill; Victoria (Sept.); Shovel Mt. (July); Mathis (Aug.); Laredo (Sept.); Mercedes; Dallas (April). OREGON: Ritter, Grant Co. (June). LOUISIANA: Sam Houston State Park (Aug).

This species is very similar to *A. schlaegeri* in coloration but it is generally smaller. The presence of an uncus with a broadened bifid tip and a broad, apically flared aedeagus in the male genitalia, and a reduced genital plate and small corpus bursae in the female genitalia readily separate this species from *A. schlaegeri*.

The name of this species has been in doubt for a number of years. The type locality for Walker's *C. algidella* is Nova Scotia and for Zeller's *C. leucillana* is Georgia. There is, according to Walsingham (1889), some color variation between the southern and northern limits of distribution and this variation is responsible for Walker's description of *C. algidella*. Although the location of Zeller's type is uncertain, a Zeller specimen from Texas labeled *C. leucillana* in the British Museum is identical to Walker's type of *C. algidella*. Obviously this problem cannot be resolved adequately until Zeller's type of *C. leucillana* is studied and compared with that of Walker's *C. algidella*; however, since indirect evidence indicates that both names

apply to the same species, and, since *C. leucillana* is the older name, the latter is adopted provisionally here.

5. *Antaeotricha osseella* (Walsingham)

FIGURES 5, 27; PLATE 1c; MAP 4

Ide osseella Walsingham, 1889, Insect Life, vol. 2, p. 155.

Brachyloma querciella Busck, 1908, Proc. Ent. Soc. Washington, vol 10, p. 111. (New synonymy).

Stenoma querciella Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.—Forbes, 1923, Cornell Agric. Exp. Sta. Mem., vol. 68, p. 253.—Busck, 1925, Proc. Ent. Soc. Washington, vol. 27, p. 48.

Stenoma osseella Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 239.

Antaeotricha osseella Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 26.

Antaeotricha querciella Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 27.

Alar expanse 22–24 mm.

Color: Face and palpus whitish sprinkled with brown scales. Legs whitish, forelegs dark fuscous anteriorly. Thorax brown dorsally. Abdomen ochreous. Forewing brown with strong lustre; with two blackish dots at end of cell, anterior one more proximal than posterior one. Hindwing light tan with white cilia.

Male genitalia: Uncus similar to *A. unipunctella*, with spatulate tip, but not as arched. Gnathos broadly notched at tip; harpes as in *A. schlaegeri;* vinculum complete, arching in front; anellus as in *A. unipunctella* but larger and notched medially; aedeagus tapering to rounded apex bearing a small apical spine. Cornuti absent.

Female genitalia: Genital plate wide, short, with median slot. Ostium bursae large; ductus bursae long, membranous; corpus bursae narrow with signum large, dentate; inception of ductus seminalis near ostium.

Type: In the British Museum (Natural History).

Type locality: California (*I. osseella*), Montclair, New Jersey (*B. querciella*).

Food plant: *Quercus alba* L., *Quercus muehlenbergii* Engelm.

Distribution: NEW YORK: Ithaca (July, Aug., Sept.). NEW JERSEY: Lakehurst (Aug., Sept.); Brown's Mills (July). NORTH CAROLINA: Highlands (June, Aug.); Brevard (Aug.). SOUTH CAROLINA: Oconee (Aug., Sept.); Greenville; Anderson (June). WEST VIRGINIA: White Sulphur Springs (July). MARYLAND: Hyattsville (May, June). DISTRICT OF COLUMBIA: Washington (Sept.). MASSACHUSETTS: Newton Highlands. PENNSYLVANIA: New Brighton (July, Aug.). ILLINOIS: Decatur (July). ARKANSAS: Washington Co. (July, Aug.). TEXAS: Burnet Co. MISSOURI: Columbia.

This species is similar in size to *A. decorosella* and *A. unipunctella*, but the coloration is distinct. The spine on the tip of the aedeagus

in the male and the median slot in the genital plate in the female are distinctive genital characters.

The identity of this species has been in doubt for some time. Keifer (1937) discusses the status of the name *osseella* and states: "At the present time I know of no further published elucidation of the application of the name *osseella*." I have examined the genitalia of Busck's type of *B. querciella* and photographs of the genitalia of Walsingham's type of *I. osseella* and found the two identical. Since Walsingham's is the older name, Busck's *B. querciella* must fall.

6. *Antaeotricha decorosella* (Busck)

FIGURES 6, 30; PLATE 1f; MAP 4

Brachyloma decorosella Busck, 1908, Proc. Ent. Soc. Washington, vol. 10, p. 111.
Stenoma decorasella [sic] Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 256.
Stenoma decorella [sic] Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 256.
Antaeotricha decorosella Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 21.

Alar expanse 22–24 mm.

Color: Face whitish ochreous; palpus brownish ochreous. Foreleg rich brown; midleg a somewhat lighter shade; hindleg white. Thorax dark brown dorsally. Abdomen whitish ochreous. Forewing dark brown; costal edge narrowly light ochreous; cell with barely perceptible darker brown apical spot. Hindwing whitish fuscous with cilia ochreous.

Male genitalia: Uncus curved, dilated at tip and only slightly indented; gnathos well developed and notched at tip; harpes as in *A. schlaegeri;* anellus with four lobes, ventral ones small amd thumblike, bearing several setae at their apex, dorsal ones large, laterally curved, with dense, brushlike group of spines on inner margin of apical third. Aedeagus long, with slightly pointed apex; cornuti absent.

Female genitalia: Genital plate large, lamella antevaginalis a small liplike band, lamella postvaginalis much larger, slightly elevated in center; ostium bursae large, slightly sclerotized; ductus bursae long, membranous; corpus bursae with large, toothed signum; inception of ductus seminalis near ostium.

Type: In the United States National Museum.

Type locality: Montclair, New Jersey.

Food plant: *Quercus ilicifolia* Wang, *Quercus marilandica* Muench.

Distribution: NORTH CAROLINA: Tryon (Aug.). NEW JERSEY: New Lisbon (Aug.); Lakehurst (July, Aug.). FLORIDA: St. Petersburg (April). MASSACHUSETTS: Martha's Vineyard (Aug.).

This species is similar to *A. unipunctella*, but it differs in the presence of a dense, brushlike group of spines on the dorsal lobes of the anellus

in the male genitalia and in the location of the genital opening at the anterior edge of the genital plate in the female.

7. *Antaeotricha furcata* (Walsingham)

FIGURES 7, 28; PLATE 2a; MAP 4

Stenoma furcata Walsingham, 1889, Insect Life, vol. 2, p. 153.—Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.

Antaeotricha furcata Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 23.

Alar expanse 27–30 mm.

Color: Face and palpus white. Legs whitish, unspotted. Thorax whitish slightly sprinkled with dusky scales dorsally, without tuft of dark scales posteriorly. Abdomen cinereous. Forewing white; patch of dark, raised scales at base of posterior edge as in *A. schlaegeri;* with brownish-grey scales extending from this to anal angle behind discal cell; with faint greyish clouds and spots at apex of cell and brownish-grey transverse line between this and apical margin. Hindwing dark cinereous in male; pale greyish ochreous in female. Cilia white, shaded with grey at tip; few divided black scales present.

Male genitalia: Uncus curved, widened, and distinctly notched at tip; gnathos somewhat reduced in size, notched at tip; harpes as in *A. schlaegeri;* anellus with four lobes, ventral ones small with pointed apex bearing several setae, dorsal ones larger, truncate, bearing several setae at apex; aedeagus long, a long recurved process near apex, apex pointed; cornuti a large cluster of very small spines.

Female genitalia: Genital plate large, lamella antevaginalis moderately large and liplike, lamella postvaginalis with two lateral depressions and median elevated area; ostium bursae large; ductus bursae short, membranous; corpus bursae with toothed signum; inception of ductus seminalis near ostium.

Type: In the British Museum (Natural History).

Type locality: Arizona.

Food plant: Unknown.

Distribution: ARIZONA: Paradise, Cochise Co. (May, June); Madera Canyon, Santa Rita Mts. (Aug., Sept., Oct.); Morrison; Nogales (May). NEW MEXICO: Ruidosa Canyon (July).

This species is similar to *A. schlaegeri* and *A. lindseyi* in color, but the distinctive aedeagus and notched uncus serve to separate the males, while the characteristic genital plate and the short, thick ductus bursae separate the females.

8. *Antaeotricha irene* (Barnes and Busck)

FIGURES 8, 8a, 29; PLATE 2b; MAP 5

Stenoma irene Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 239.

Antaeotricha irene Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 24.

Alar expanse 19–20 mm.

Color: Face white; palpus white sprinkled with brown exteriorly. Legs white; foreleg with dark scales on outer side, mid- and hindlegs with dusky tarsi. Thorax ranging from dark fuscous to white dorsally with somewhat large, dark, rounded tuft posteriorly. Abdomen white sprinkled dorsally with dusky scales. Females with forewing white, extreme base of posterior edge fuscous; conspicuous dark spot at apical two-thirds; more distal, lighter, irregular band extending to posterior edge; and still more distal, very faint, narrow, transverse, outwardly curved line across apical part of wing. In some specimens a cloudy spot at midlength of posterior edge. Male with entire basal portion of forewing blackish brown and, in addition to markings of female, with additional cloudy, ill-defined, more or less transverse areas on middle of forewing and across apical third; also an interrupted line of small black marginal dots on apex. Hindwing light whitish fuscous; cilia white.

Male genitalia: Uncus simple; gnathos well developed and pointed at tip; harpes as in *A. schlaegeri;* anellus narrow, with two small lobes; aedeagus large, sharply pointed at apex; cornuti a long mass of small spines.

Female genitalia: Genital plate a small band; ostium bursae sclerotized, opening near center of genital plate; ductus bursae long, membranous from ostium bursae to midlength, sclerotized from midlength to corpus bursae; corpus bursae with dentate signum; inception of ductus seminalis near ostium.

Type: In the United States National Museum.

Type locality: Brownsville, Texas.

Food plant: *Sida* spp.

Distribution: Texas: Brownsville (Jan., June); San Benito (July, Aug., Sept.).

This species is intermediate between *A. leucillana* and *A. vestalis* in color, differing, in the male genitalia, by the presence of a simple uncus and a large cornutus in the aedeagus, and, in the female, by the lower part of the ductus bursae being sclerotized.

9. *Antaeotricha humilis* (Zeller)

Figures 11, 31; Plate 2c; Map 5

Cryptolechia humilis Zeller, 1855, Linn. Entom., vol. 10, p. 156.
Cryptolechia nebeculosa Zeller, 1873, Verh. Zool.-Bot. Ges. Wien, vol. 23, p. 245.
Harpalyce canusella Chambers, 1874, Canadian Ent., vol. 6, p. 235.
Stenoma humilis Walsingham, 1889, Insect Life, vol. 2, p. 154.—Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.
Antaeotricha humilis Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 24.

Alar expanse 12–15 mm.

Color: Face white sprinkled with brown; palpus white, sprinkled with brown exteriorly. Foreleg brown, tarsi ringed with white;

midleg white sprinkled with brown; hindleg white. Thorax brown dorsally, without posterior tuft. Abdomen whitish ochreous. Forewing ash grey with three diffuse brown spots on anterior margin; three dark dots in midline, middle dot less distinct; two transverse bands on posterior margin; faint, curved subterminal band and row of dark terminal dots. Hindwing light tan; cilia tan.

Male genitalia: Uncus curved, dilated at tip; gnathos well developed, somewhat pointed at tip; harpes as in *A. schlaegeri;* anellus V-shaped, without lobes; aedeagus small, with slightly pointed apex; cornuti absent.

Female genitalia: Genital plate small, lamella antevaginalis and lamella postvaginalis not differentiated. Ostium bursae sclerotized, opening at posterior margin of genital plate; ductus bursae long, membranous; corpus bursae with large sclerotized signum; inception of ductus seminalis near ostium; anterior apophyses short, not fused to genital plate.

Type: Not known.

Type locality: South Carolina (*C. humilis*), Texas (*C. nebeculosa, H. canusella*).

Food plant: *Quercus* sp. This species has been reared by the author from larvae collected on oak in North Carolina in July. The larvae tie two leaves together and feed between them. Pupation occurs in the space between the two tied leaves. These observations are casual and a more thorough study of the life history of this species is planned.

Distribution: NORTH CAROLINA: Brevard (June); Tryon (June); Southern Pines (May, June, Sept.); Kinston (July). SOUTH CAROLINA: Oconee (Aug., Sept.). FLORIDA: Gainesville (July); Venice (Dec.); Lake Alfred (July); Royal Palm State Park; Paradise Key (March); Miami; Glenwood; Vero Beach (Feb.); St. Petersburg (May); Panacea (Aug.); Pensacola (Sept.). MISSOURI: Kirkwood (April). MISSISSIPPI: Bay St. Louis (June); Clinton (May). TENNESSEE: Monteagle (July). VIRGINIA: Cape Henry (Aug.); Falls Church (Aug.). ILLINOIS: Oconee (July, Aug.). MARYLAND: Plummers Island (May); Hyattsville (July). TEXAS: Waco; Kerrville (April). INDIANA: Hessville (May). NEW JERSEY: Anglesea (May, June); Lakehurst (May). LOUISIANA: Vowell's Mill (April).

This species is similar to *A. vestalis* in size and coloration, but closer to *A. thomasi* in structures of the male and female genitalia. It is readily separable by the V-shaped anellus without lateral lobes in the male and by the presence of free anterior apophyses in the female.

10. *Antaeotricha agrioschista* (Meyrick)

FIGURES 10, 10a, 34; PLATE 2d; MAP 5

Stenoma agrioschista Meyrick, 1927, Exotic Microlepidoptera, vol. 3, p. 365.—Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 32.

Antaeotricha agrioschista Clarke, 1955b, Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 2, p. 16, pl. 8, figs. 1–1b.

Alar expanse 20–21 mm.

Color: Antennae mixed brown and white. Face white, lightly shaded with brown; palpus white sprinkled with brown, base of second segment and subapical band of apical segment brown. Legs white, shaded with brown, progressively lighter to rear. Thorax and tegula white heavily shaded with brown. Abdomen white shaded with brown. Forewing white overlaid brown, sprinkled with fuscous; short transverse fuscous line from base of costa; three oblique transverse fuscous lines from costa, one at basal fourth, one at middle and one at apical fourth; cilia white mixed with brown. Hindwing light brown; cilia whitish with brown subbasal line.

Male genitalia: Uncus arched, area near middle expanded ventrally and laterally flattened; gnathos broad, rounded at tip; vinculum complete, arched in front, notched at apex of arch; anellus without lateral lobes; aedeagus slender; cornuti a long cluster of heavy spines.

Female genitalia: Genital plate with excavation on posterior margin. Ostium bursae large, sclerotized; ductus bursae short, membranous; corpus bursae with large sclerotized signum; anterior apophyses short, not fused to genital plate.

Type: In the British Museum (Natural History).

Type locality: Alpine, Texas, 5000–8000 ft.

Food plant: Unknown.

Distribution: TEXAS: Alpine, 5000–8000 ft. (April, May, June).

This species is nearest *A. humilis*, as noted by Meyrick in the original description. The presence of cornuti in the aedeagus and the notched vinculum in *A. agrioschista* readily separate the males, while the excavation on the posterior margin of the genital plate separates the females.

11. *Antaeotricha thomasi* (Barnes and Busck)

FIGURES 12, 32; PLATE 2e; MAP 6

Stenoma thomasi Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 240.

Antaeotricha thomasi Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 29.

Alar expanse 21–24 mm.

Color: Face and palpus creamy white. Legs white sprinkled with dusky scales; tarsal joints dusky. Thorax and abdomen creamy

white. Forewing yellowish creamy white. Hindwing creamy white. Cilia white.

Male genitalia: Uncus curved, attenuated, and cleft at tip; gnathos somewhat pointed at tip; harpes as in *A. schlaegeri;* anellus without distinct lobes, aedeagus bluntly pointed at apex; cornuti a group of heavy spines.

Female genitalia: Genital plate small, bandlike; lamella antevaginalis and postvaginalis similar in size and shape forming liplike structure; ostium bursae and ductus bursae sclerotized; ductus bursae short; corpus bursae large, membranous, with large signum; inception of ductus seminalis near ostium.

Type: In the United States National Museum.

Type locality: Palmerlee, Arizona.

Food plant: Unknown.

Distribution: ARIZONA: Paradise, Cochise Co. (Aug.); Huachuca Mts. NEW MEXICO: Albuquerque (July). COLORADO: Rock Creek Canyon (Aug.).

This species is similar to *A. vestalis* in size and color, but the attenuated cleft uncus in the male distinguishes *A. thomasi* from all other described North American species of this genus.

12. *Antaeotricha haesitans* (Walsingham)

FIGURES 13, 35; PLATE 2f; MAP 6

Aedemoses haesitans Walsingham, 1912, Lepidoptera-Heterocera, vol. 4 (vol. 42 *in* Godman and Salvin, Biologia Centrali-Americana), p. 154.

Aedemoses hessitans [sic] Heinrich, 1921, Journ. Agric. Res., vol. 20, p. 816.

Antaeotricha hesitans [sic] Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 23.

Alar expanse 12 mm.

Color: Face and palpus ochreous, palpus shaded with fuscous; legs pale ochreous. Thorax ochreous dorsally. Abdomen ochreous. Forewing pale ochreous with two oblique fuscous lines on apical half, more basal one extending from origin of costal cilia directly to tornus, apical one extending from dot near tornus obliquely to costa; minute fuscous spot at base of cell and another at its apex; a few minute fuscous dots at wing apex near base of cilia. Hindwing ochreous, cilia ochreous.

Male genitalia: Uncus long, broadened apically, somewhat indented, gnathos well developed, sharply pointed at tip; harpes as in *A. schlaegeri;* vinculum complete; anellus with two upright, sharply pointed lobes curving laterad, one on either side of aedeagus; aedeagus long, thin, with many sharp processes at apex; cornuti absent.

Female genitalia: Genital plate short, lamella antevaginalis small, forming triangular flap over ostium, lamella postvaginalis larger, smooth; ostium bursae and ductus bursae membranous; corpus bursae

membranous, without signum; inception of ductus seminalis near ostium.

Type: In the British Museum (Natural History).

Type locality: Presidio, Durango, Mexico.

Food plant: *Pitheoellobium flexicaule* Benth. Heinrich (1921) states that the larva is a leaf-tyer, feeding on the food plant by binding together several leaves and feeding within the tie, eating first the epidermis and later all but the veins of the leaves. Pupation occurs within the tie, the pupa being naked and attached to one of the leaves by a strand of silk.

Distribution: TEXAS: Brownsville (March, April, June, Aug.).

Walsingham described a new genus, *Aedemoses*, and a new species based on a unique female with hindlegs missing, collected at Presidio, Durango, Mexico.

13. *Antaeotricha fuscorectangulata*, new species

FIGURES 14, 14a, 33; PLATE 3a; MAP 7

Alar expanse 17–19 mm.

Color: Antenna brown, irregularly shaded with white. Face whitish, shaded lightly with brown; second segment of palpus white; exterior brown basally; apical segment white. Legs whitish shaded with brown, tarsi fuscous, inner side of foreleg fuscous. Thorax ochreous, tegula whitish. Abdomen fuscous dorsally; ochreous ventrally. Forewing white shaded with ochreous, rectangular fuscous area along inner margin of middle third; two fuscous costal spots, one near middle and one at apical fourth; from latter a row of black dots extends from apex along termen to tornus; apical fourth flecked with black scales; two fuscous dots on cell, one basal, one distal; cilia brown basally and apically, white medially. Hindwing light fuscous with whitish costal margin; cilia light fuscous basally, white beyond.

Male genitalia: Uncus arched, spatulate at apex; gnathos rounded at tip; vinculum complete, produced into dorsally projecting process in front; anellus with two laterally curved, pointed lobes; aedeagus long, slender; cornuti a cluster of heavy spines.

Female genitalia: Genital plate small, undifferentiated. Ostium bursae sclerotized, opening at posterior margin of genital plate, pouchlike evagination between opening and inception of ductus seminalis; ductus bursae long, membranous; corpus bursae with large sclerotized signum; anterior apophyses short, not fused to genital plate.

Type: South Fork of Cave Creek, Chiricahua Mts., Arizona. USNM 65824.

Food plant: Unknown.

Distribution: ARIZONA: South Fork of Cave Creek, Chiricahua Mts. (July); Madera Canyon, 4880 ft., Santa Rita Mts. (July).

Described from the male holotype, July 4, 1939, collected by A. F. Braun, South Fork Cave Creek, Chiricahua Mts., Arizona; one male paratype, July 17, 1959, and four female paratypes, July 18, 19, 20, 25, 1959, collected by Ronald W. Hodges, Madera Canyon, 4880 ft., Santa Rita Mts., Arizona.

This species is nearest *A. haesitans*, but it is readily separable by the vinculum produced into a dorsally projecting process in front in the male genitalia and by the pouchlike evagination of the ostium bursae in the female genitalia.

14. *Antaeotricha vestalis* (Zeller)

FIGURES 9, 9a, 36; PLATE 3b; MAP 7

Cryptolechia vestalis Zeller, 1873, Verh. Zool.-Bot. Ges. Wien, vol. 23, p. 247.
Ide vestalis Walsingham, 1889, Insect Life, vol. 2, p. 155.
Stenoma vestalis Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.—Meyrick, 1922, *in* Genera Insectorum, vol. 180, p. 82.
Antaeotricha vestalis Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 30.

Alar expanse 15–21 mm.

Color: Face white; palpus white with dusky scales on exterior sides in male. Legs white sprinkled with dusky scales. Thorax white dorsally. Abdomen white. Forewing white, costal edge slightly ochreous. Hindwing white; cilia white.

Male genitalia: Uncus curved, dilated at tip; gnathos large, divided into two distinct, sharp-pointed lobes; harpes as in *A. schlaegeri*; anellus with four lobes, ventral ones small and thumblike, bearing several setae at their apex, dorsal ones larger, blunter, bearing numerous heavy setae. Aedeagus long, rounded at apex; cornuti absent.

Female genitalia: Genital plate without distinct division into lamella antevaginalis and lamella postvaginalis, ostium bursae small, opening near center of genital plate; ductus bursae long, membranous; corpus bursae with small, dentate signum; inception of ductus seminalis near ostium.

Type: In the Museum of Comparative Zoology, Harvard University.

Type locality: Texas (*C. vestalis*).

Food plant: Unknown.

Distribution: FLORIDA: Lake Placid (April, Dec.); Florida City (March); Royal Palm State Park (March, Sept.); Everglades (April); Fort Myers (April); Marco (April); St. Petersburg (Oct.); Paradise Key (March); Lakeland (March); Miami; Panacea (Aug., Oct.); Altamont; Glenwood. GEORGIA: Billy's Island, Okefenokee Swamp (June, July); Spring Creek (July). MISSISSIPPI: Ocean Springs

(Aug.). SOUTH CAROLINA: no locality (Feb.). TEXAS: Burnet Co. (Oct.); Kerrville. NEW JERSEY: Lakehurst (July, Sept.).

This species is similar to *A. irene* but it is distinguishable by the apically dilated uncus, by the gnathos with two sharp-pointed lobes, and by the anellus with four lobes in the male genitalia. The absence of specialized structures around the ostium serves to distinguish the females.

Walsingham (1889) synonymized *Harpalyce albella* Chambers with *I. vestalis;* however, examination of Chambers' type located in the Museum of Comparative Zoology reveals that *H. albella* belongs in the genus *Durrantia* Busck and is so transferred.

15. *Antaeotricha manzanitae* Keifer

FIGURES 15, 37; PLATE 3c; MAP 7

Antaeotricha manzanitae Keifer, 1937, California Dept. Agric. Bull., vol. 26, p. 334.

Alar expanse 25–30 mm.

Color: Face whitish ochreous; palpus overlaid with fuscous. Legs white, overlaid with fuscous; foreleg darkest, mid- and hindleg progressively lighter. Thorax white dorsally with brownish-black tuft posteriorly. Abdomen white. Forewing white, irregularly shaded fuscous scales; two patches of dark scales at anal angle; apical margin with row of faint, transverse, fuscous dots. Cilia fuscous, white tipped. Hindwing light fuscous; cilia lighter.

Male genitalia: Uncus curved, dilated at tip, terminating in two short spines; gnathos well developed, ending in short blunt tip; harpes as in *A. schlaegeri*; anellus with two lobes, one on each side of aedeagus. Aedeagus short and broad; cornuti a small cluster of spines.

Female genitalia: Genital plate small, bandlike; ostium bursae and ductus bursae membranous; corpus bursae corrugated; inception of ductus seminalis near ostium.

Type: In the California Academy of Science.

Type locality: Shingle Springs, El Dorado Co., California.

Food plant: *Arctostaphylos* sp. Keifer (1937) gives a thorough account of the life history of this species with numerous illustrations.

Distribution: CALIFORNIA: Shingle Springs, El Dorado Co. (April); Palm Desert (Apr.); Big Basin (July); Mt. Shasta City, Siskiyou Co. (July); Hat Creek, Shasta Co. (June). OREGON: Tiller (June). BRITISH COLUMBIA: Wellington (July).

This species is similar in size and color to *A. schlaegeri*, but it is separable by the presence of two small spines on the tip of the uncus in the male and by the corrugated corpus bursae in the female.

Genus *Stenoma* Zeller

Stenoma Zeller, 1839, Isis von Oken, vol. 32, p. 195.

1. *Stenoma mistrella* Busck

FIGURES 16, 39; PLATE 3d; MAP 8

Stenoma mistrella Busck, 1907, Proc. Ent. Soc. Washington, vol. 8, p. 93.—Walsingham, 1913, Lepidoptera-Heterocera, vol. 4 (vol. 42 *in* Godman and Salvin, Biologia Centrali-Americana), p. 183.—Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.—Busck and Dampf, 1929, Estud. Ofic. Fed. Agric. Mexico, vol. 2, p. 13.—Busck, 1934, in Lepidopterorum catalogus, vol. 67, p. 49.

Alar expanse 20–23 mm.

Color: Face white; palpus light fuscous. Legs ochreous; forelegs dark anteriorly. Thorax light ochreous dorsally. Abdomen dark fuscous. Forewing ranging from light ochreous, minutely speckled and overlaid with darker brown scales, to uniform dark fuscous; small, conspicuous, round black dot at apex of cell; costa nearly straight, apex pointed. Hindwing dark fuscous; cilia light ochreous.

Male genitalia: Uncus reduced, knoblike; gnathos incomplete in front; harpes simple, somewhat pointed at apex, bearing short, stiff, bifurcate setae; vinculum complete; anellar lobes broad, pointed apically; aedeagus large, flared apically; cornuti two clusters of very heavy spines.

Female genitalia: Genital plate small, lamella postvaginalis fused medially with eighth sternite; ostium bursae large, somewhat sclerotized; ductus bursae membranous; corpus bursae with lightly sclerotized signum. Inception of ductus seminalis near ostium.

Type: In the United States National Museum.

Type locality: St. Louis, Missouri.

Food plant: *Phleum pratense* L., bromegrass, and Kentucky bluegrass. Miller (1940) reports that the larvae construct sheltered tubes at the base of grass similar to *Crambus* sp. and feed on the edge of the neighboring grass blades.

Distribution: MISSISSIPPI: Jackson (July, Sept.); Pearl (June, Sept.). MISSOURI: St. Louis (April, July). OHIO: Cincinnati (July). ILLINOIS: Chicago (June); Decatur (June, Aug., Sept.); Lacon (Sept.). TEXAS: Victoria (July). KANSAS: Onaga. PENNSYLVANIA: Pittsburgh (Sept.). NEW MEXICO: Frijoles Canyon (Sept.). MANITOBA: Winnipeg.

This species is readily separated from *Stenoma crambitella* by the flared apex of the aedeagus in the male and by the presence of only one lightly sclerotized signum in the female.

2. *Stenoma crambitella* Walsingham

FIGURES 17, 40; PLATE 3e; MAP 8

Stenoma crambitella Walsingham, 1889, Insect Life, vol. 2, p. 154.—Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.—Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 38.

Alar expanse 22 mm.

Color: Face and palpus white, palpus shaded with pale brownish ochreous scales. Legs whitish, shaded with brown scales. Thorax white dorsally. Abdomen whitish ochreous. Forewing white, few grayish fuscous scales on extreme costal margin basally and single dot of same color at apex of cell, apex somewhat pointed. Hindwing white, tinged with ochreous; cilia white.

Male genitalia: Uncus reduced in size, but not as much as in *S. mistrella;* gnathos complete in front, forming a band; harpes as in *S. mistrella,* but blunt at apex; vinculum complete; anellar lobes long, slender; aedeagus short, broad; cornuti a small cluster of heavy spines.

Female genitalia: Genital plate small, lamella postvaginalis fused laterally with eighth sternite; ostium bursae large; ductus bursae long, membranous; corpus bursae with two lightly sclerotized, dentate signa. Inception of ductus seminalis near ostium.

Type: In the British Museum (Natural History).

Type locality: Arizona.

Food plant: Unknown.

Distribution: ARIZONA: Palmerlee; Redington; Santa Rita Mts. (June); Santa Catalina Mts.; Chiricahua Mts. (Aug.). TEXAS: Kerrville (June).

This species differs from *Stenoma mistrella* in the differently shaped aedeagus in the male and in the presence of two lightly sclerotized signa in the female.

Genus *Setiostoma* Zeller

Setiostoma Zeller, 1875, Verh. Zool.-Bot. Ges. Wien, vol. 25, p. 324.

1. *Setiostoma xanthobasis* Zeller

FIGURES 18, 18a, 41; PLATE 3f; MAP 9

Setiostoma xanthobasis Zeller, 1875, Verh. Zool.-Bot. Ges. Wien, vol. 25, p. 324.—Busck, 1925, Proc. Ent. Soc. Washington, vol. 27, p. 48; 1934, *in* Lepidopterorum catalogus, vol. 67, p. 2.

Alar expanse 12–14 mm.

Color: Face and palpus lemon yellow. Legs dark brown; foreleg with coxa entirely white, tarsi ringed with white; midleg with two tibial rings; tibial spurs and tarsal rings white. Thorax brown

dorsally except tegulae, which are lemon yellow. Abdomen brown with patches of white scales laterally. Forewing deep brown, with lemon yellow triangular area, continuous with yellow tegula, occupying basal third except short costal lenticular spot and longer, narrower spot along posterior wing margin, both spots concolorous with ground color. Apical two-thirds of forewing with inconspicuous area of white scales near midlength of costal margin and similar, smaller area slightly more distad; broad transverse band, parallel to distal margin of yellow spot, small group of scales behind more basal white area, short curved band extending caudolaterad from more distal white area, submarginal longer straight band parallel to outer wing margin, iridescent blue. Cilia blackish brown. Hindwing dark brown with patch of white on basal half of anterior margin; cilia brown edged in white.

Male genitalia: Uncus pointed; gnathos a simple band; harpes simple with palmate multilobed hairs on outer part of costa; vinculum narrow, incomplete in front, anellus with two flattened, upright lobes; aedeagus large with apex pointed; cornuti a large cluster of small spines and one large single spine.

Female genitalia: Genital plate membranous; ostium bursae large, trumpet-shaped; ductus bursae membranous; corpus bursae with signum large, dentate; inception of ductus seminalis near ostium.

Type: In the Museum of Comparative Zoology, Harvard University.

Type locality: Texas.

Food plant: *Quercus* sp. According to Forbes (1923), the larva is found in a nest about two centimeters in diameter, formed by an oval wall of silk between two slightly separated oak leaves, and it feeds on the lower parenchyma only.

Distribution: MASSACHUSETTS: Martha's Vineyard. NEW JERSEY: Lacy (July). MARYLAND: Annapolis (Aug.). DISTRICT OF COLUMBIA: Washington (July). NORTH CAROLINA: Southern Pines (Aug.). GEORGIA: Spring Creek (July). FLORIDA: Enterprise (April); Lakeland (May). ILLINOIS: no locality. MISSOURI: no locality (May).

This species is very closely related to *S. fernaldella* Riley, but it is distinguished readily by its single large spine and by a cluster of small spines in the aedeagus of the male, and by its heavily sclerotized, dentate signum in the corpus bursae of the female.

2. *Setiostoma fernaldella* Riley

FIGURES 19, 19a, 42; PLATE 4a; MAP 9

Setiostoma fernaldella Riley, 1889, Proc. Ent. Soc. Washington, vol. 1, p. 155.—Busck, 1934, *in* Lepidopterum catalogus, vol. 67, p. 1.

Alar expanse 12–13 mm.

Color: Face yellow sprinkled with brown; palpus yellow. Legs

blackish brown; foreleg with coxa white or yellowish, tarsi ringed with white; spurs of midtibia white, with few dusky scales, and midtarsi ringed with white; hindleg with two tibial rings, spurs and tarsal rings white. Thorax greenish yellow dorsally sprinkled with brown scales. Abdomen dark brown with metallic iridescence. Forewing with triangular marking of basal third as in *S. xanthobasis* but greenish yellow, concolorous and continuous with greenish yellow of thorax, and with darker spot along posterior margin much shorter and more restricted to anal region. Apical two-thirds dark brown with iridescent bronze-to-violet markings, in reflected light, in transverse band across middle third of wing and an area that curves near wing apex and extends parallel to outer wing margin. Hindwing as in *S. xanthobasis*.

Male genitalia: As in *S. xanthobasis* with exception of anellus, which bears upright, median, dentate process in addition to two lateral flattened upright processes, and cornuti, which consist of several large single spines.

Female genitalia: As in *S. xanthobasis* with exception of absence of signum in corpus bursae and presence of sclerotized plate at junction of ostium bursae and ductus bursae.

Type: In the United States National Museum.

Type locality: Los Angeles, California.

Food plant: *Quercus wislizenii* A. DeCandolle and *Quercus agrifolia* Nee.

Distribution: CALIFORNIA: Forest Home, San Bernardino Co. (June); Los Angeles Co. (July); San Diego (June, July); Baldy Mts. (June); Pasadena (June); Santa Clara. ARIZONA: Madera Canyon, Santa Rita Mts. (July, Aug., Sept.); Pena Blanca Canyon (Sept.).

This species is readily distinguished from *S. xanthobasis* by its cornuti that consists of more than one large single spine in the aedeagus of the male and by the absence of a signum in the corpus bursae of the female.

Genus *Mothonica* Walsingham

Mothonica Walsingham, 1912, Lepidoptera-Heterocera, vol. 4 (vol. 42 *in* Godman and Salvin, Biologia Centrali-Americana), p. 153.

1. *Mothonica kimballi*, new species

FIGURES 20, 20a, 38; PLATE 4b; MAP 10

Alar expanse 17–19 mm.

Face ochreous shaded with fuscous; palpus white sprinkled with fuscous, apical segment tipped with fuscous, second segment shaded with fuscous basally. Legs creamy white, hindtibia with long hairs above, fore- and midleg shaded heavily with fuscous. Thorax

smooth, white sprinkled with fuscous dorsally. Abdomen white, shaded to various degrees with fuscous. Forewing long, somewhat narrow; ground color white, with three large fuscous areas along costa; marginal and submarginal transverse row of fuscous dots at apex, marginal row darker and giving sinuated effect to termen; another area of dark fuscous raised scales at anal angle. Anterior half of cilia light fuscous, posterior half white. Hindwing very light fuscous; cilia fuscous basally, white apically.

Male genitalia: Uncus simple, short, with group of setae at apex; gnathos two lateral plates flanking tuba analis; harpes with pincer-shaped costa, apex somewhat pointed and recurved, bearing heavy bifurcate setae; sacculus with prominent bifurcate lobe; vinculum complete; anellus a large rectangular plate with large upright lateral lobes; aedeagus large basally, tapering apically to a point, cornuti two large clusters of heavy spines.

Female genitalia: Genital plate large, with large median slot. Ostium bursae sclerotized, ductus bursae short, membranous; corpus bursae large, with large dumbbell-shaped, dentate signum; anterior apophyses long, not fused to genital plate.

Type: Siesta Key, Sarasota County, Florida. USNM 65825.

Food plant: Unknown.

Distribution: FLORIDA: Siesta Key, Sarasota County (Jan., Feb., March, April, May, Nov.); Vero Beach (April).

Described from the male holotype, Jan. 24, 1954, two male paratypes, Feb. 26, 1954, Jan. 15, 1954, collected by C. P. Kimball, Siesta Key, Sarasota County, Florida; two male paratypes, April 2, 1941, collected by J. R. Malloch, Vero Beach, Florida; one female paratype, March 4, 1953, collected by C. P. Kimball, Siesta Key, Sarasota County, Florida.

This is the first species of the genus *Mothonica* to be described from North America. It is very similar to *Mothonica fluminata* (Meyrick), a Colombian species. The bifurcate lobe on the harpe of *M. kimballi* readily separates the males. No females of *M. fluminata* were available for comparison.

This species is named in honor of Mr. C. P. Kimball of West Barnstable, Massachusetts, who provided material from his personal collection for description.

Genus *Menestomorpha* Walsingham

Menestomorpha Walsingham, 1907, Proc. U.S. Nat. Mus., vol. 33, p. 214.

1. *Menestomorpha oblongata* Walsingham

FIGURES 21, 43; PLATE 4c; MAP 11

Menestomorpha oblongata Walsingham, 1907, Proc. U.S. Nat. Mus., vol. 33, p. 215.—Barnes and Busck, 1920, Contrib. Nat. Hist. Lep. North America, vol. 4, p. 238.—Busck, 1934, *in* Lepidopterorum catalogus, vol. 67, p. 4.

Alar expanse 15 mm.

Color: Face and palpus white flecked with brown scales, palpus brown at tip. Legs white flecked with brown scales, tarsi ringed with brown. Thorax white flecked with brown scales. Abdomen with mixed brown and white scales. Forewing white with two transverse brown bands converging at anal angle forming V-shaped mark on basal third, middle third with indistinct brown shading blending into indistinct brown streaks in apical third that follow lines of veins beyond cell to termen and costa; with row of five or six indistinct brownish dots along termen reaching to apex; cilia brown tipped in white. Hindwing light brown; cilia lighter, with light greyish-fuscous line along margin at base and two parallel shades running through it.

Male genitalia: Uncus very small bearing several small setae at apex; gnathos with two small processes beneath uncus; harpes with large lobe basally, median forked structure, and somewhat pointed apical lobe bearing short, bifurcate setae; vinculum complete; anellus with two large, pointed processes surrounding and extending above aedeagus; aedeagus short, pointed laterally; cornuti a small cluster of heavy spines.

Female genitalia: Genital plate reduced to simple band surrounding ostium; ostium bursae and ductus bursae membranous; corpus bursae large; membranous, with two dentate, lightly sclerotized signa.

Type: In the British Museum (Natural History).

Type locality: Fort Grant, Arizona.

Food plant: The type series was reared from a cynipid gall on *Quercus* sp.

Distribution: ARIZONA: Fort Grant (April); Baboquivari Mts. (Oct.); Madera Canyon, Santa Rita Mts. (July, Aug., Sept., Oct.). CALIFORNIA: San Bernardino Co. (June).

Genus *Menesta* Clemens

Menesta Clemens, 1860, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, p. 213.

1. *Menesta tortriciformella* Clemens

FIGURES 23, 44; PLATE 4d; MAP 12

Menesta tortriciformella Clemens, 1860, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, p. 213; 1872, The Tineina of North America, p. 151.—Chambers, 1878, Bull. U.S. Geol. Surv., vol. 4, p. 157.—Walsingham, 1881, Proc. Zool. Soc. London, p. 319; 1889, Insect Life, vol. 2, p. 154.—Busck, 1903b, Proc. U.S. Nat. Mus., vol. 25, p. 903; 1934, *in* Lepidopterorum catalogus, vol. 67, p. 5.

Gelechia liturella Walker, 1864, List of the specimens of lepidopterous insects in the collection of the British Museum, vol. 29, p. 591.

Hyale coryliella Chambers, 1875, Cincinnati Quart. Journ. Sci., vol. 2, p. 242.

Strobisia albaciliacella Chambers, 1878, Canadian Ent., vol. 10, p. 77. (New synonymy.)

Menesta albaciliaecella Busck, 1903b, Proc. U.S. Nat. Mus., vol. 25, p. 903; 1934, *in* Lepidopterorum catalogus, vol. 67, p. 5.

Menesta albiciliella [sic] Walsingham, 1911, Lepidoptera-Heterocera, vol. 4 (vol. 42 *in* Godman and Salvin, Biologia Centrali-Americana), p. 104.

Menesta albaciliella [sic] Braun, 1915, Ent. News, vol. 26, p. 160.

Alar expanse 9–10 mm.

Color: Face and palpus white, palpus shaded with fuscous. Legs white, shaded anteriorly with fuscous, especially apex of tibia and apices of tarsi, hindtibia with long hairs. Thorax brown dorsally, with grayish hue. Abdomen brown dorsally, white ventrally. Forewing blackish brown with greenish-violet reflections; few white scales just beyond middle forming indistinct, short, transverse line; apical cilia white or brown, remainder brown. Hindwing much lighter brown; cilia brown, tipped with white apically.

Male genitalia: Uncus simple, large basally, tapering to point apically, curved ventrad parallel to gnathos; gnathos well developed, very long, blunt apically; harpes simple, bluntly rounded at apex, bearing large cluster of small, stiff, bifurcate setae; vinculum complete, anellus with two lateral lobes partially encircling aedeagus, aedeagus pointed apically; cornuti consisting of two large, heavy spines.

Female genitalia: Genital plate reduced to small median triangular sclerite; ostium bursae slightly sclerotized; ductus bursae with dilated area before inception of ductus seminalis; corpus bursae with large, heavily sclerotized, cross-shaped signum with outwardly projecting median lobe; inception of ductus seminalis approximately halfway between ostium and corpus bursae. Anterior apophyses free, arising ventrally.

Type: In the Academy of Natural Sciences of Philadelphia.

Type locality: Pennsylvania (*M. tortriciformella*), Kentucky (*H. coryliella*), Nova Scotia (*G. liturella*), Cincinnati, Ohio (*S. albaciliaecella*).

Food plant: *Rubus Villosus* Ait. and *Corylus americana* Walt. Chambers (1875) and Braun (1915) give accounts of the life history of this species.

Distribution: OHIO: Cincinnati (May, June, July). PENNSYLVANIA: Harvey's Lake (June). NEW JERSEY: Essex Co. (June). NEW YORK: Buffalo (June); Peru (June); Protection (June). MARYLAND: Cabin John (May). VIRGINIA: Ocean View (July). ONTARIO: Kearney (July).

This species has been known previously only from its type, which Busck (1903) incorrectly reported as being without an abdomen. The genitalia of the type of *M. tortriciformella* has been studied and found to be identical with those of *S. albaciliaecella*. This synonymy is not surprising because the only characters used in the past to separate the two species were slight differences in the color of the head

and the presence or absence of white apical cilia on the forewing.

This species closely resembles *M. melanella* in both superficial appearance and in structure of the genitalia; however, *M. tortriciformella* lacks on the costa of the forewing the white spot that is present in *M. melanella*. The genitalia differ from those of *M. melanella* in that the cornuti in the aedeagus of the male consist of two large heavy spines and the signum in the corpus bursae of the female is cruciform.

2. *Menesta melanella* Murtfeldt

FIGURES 22, 45; PLATE 4e; MAP 12

Menesta melanella Murtfeldt, 1890, Insect Life, vol. 2, p. 304.—Busck, 1903b, Proc. U.S. Nat. Mus., vol. 25, p. 903; 1934, *in* Lepidopterorum catalogus, vol. 67, p. 5.

Alar expanse 10–12 mm.

Color: Face and palpus white. Legs white shaded lightly with fuscous. Thorax blackish brown dorsally. Abdomen blackish brown dorsally, white ventrally. Forewing blackish brown with greenish-violet reflections, triangular patch of white scales on costa about midway between base and apex; cilia brownish black, white apically. Hindwing with broad white streak extending along costa from base to beyond midpoint; cilia brown with patches of white near outer angle and near base.

Male genitalia: Uncus as in *M. tortriciformella* except apex not as sharply pointed; gnathos as in *M. tortriciformella* except apex, which ends in a sharp point; harpes and vinculum as in *M. tortriciformella*; anellus with two lateral lobes as in *M. tortriciformella* but larger and not encircling aedeagus; aedeagus slightly pointed apically; cornuti consisting of one large heavy spine.

Female genitalia: Genital plate, ostium bursae, and ductus bursae as in *M. tortriciformella;* corpus bursae with heavily sclerotized, rectangular signum with median lobe; inception of ductus seminalis near ostium, anterior apophyses as in *M. tortriciformella*.

Type: In the United States National Museum.

Type locality: Missouri.

Food plant: *Quercus stellata* Wangh. Murtfeldt (1890) gives an account of the life history of this species.

Distribution: SOUTH CAROLINA: Oconee (Aug.). NEW JERSEY: Lakehurst (June). MASSACHUSETTS: Martha's Vineyard (June). FLORIDA: Dade City (April). VIRGINIA: Falls Church (Aug.). ARIZONA: Madera Canyon, Santa Rita Mts. (Aug.).

From *M. tortriciformella*, which it resembles, this species differs by a white spot being present on the costal edge of the forewing, by the cornuti consisting of one large heavy spine in the male genitalia, and by the signum being rectangular in the female genitalia.

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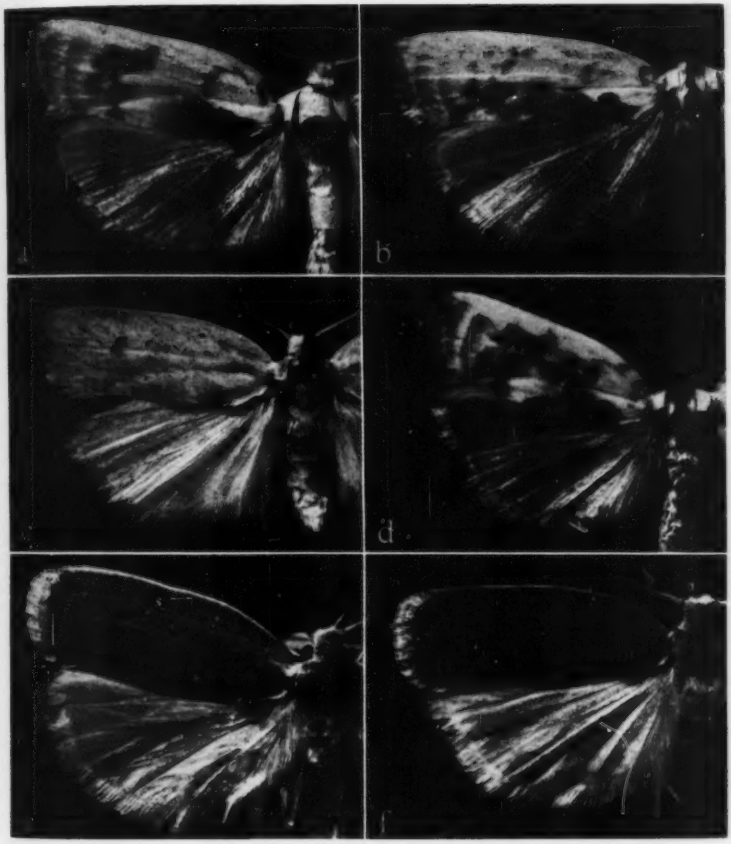


PLATE 1.—a, *Antaeotricha schlaegeri* Zeller; b, *A. lindseyi* (Barnes and Busck); c, *A. unipunctella* (Clemens); d, *A. leucillana* (Zeller); e, *A. osseella* (Walsingham); f, *A. decorosella* (Busck).

PLATE 2.—a, *Antaeotricha furcata* (Walsingham); b, *A. irene* (Barnes and Busck); c, *A. humilis* (Zeller); d, *A. agrioschista* (Meyrick); e, *A. thomasi* (Barnes and Busck); f, *A. haesitans* (Walsingham).

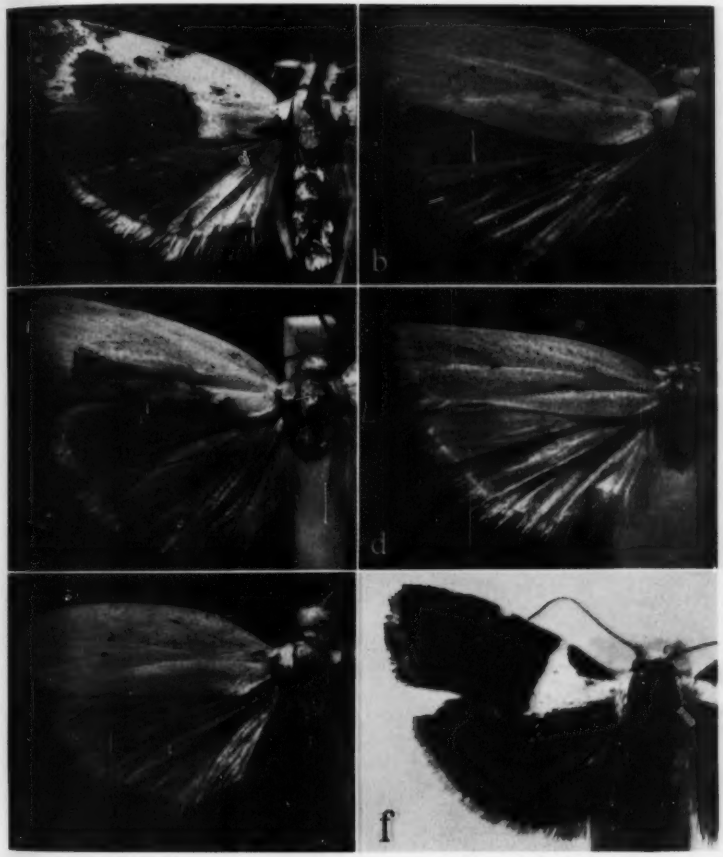


PLATE 3.—a, *Antaeotricha fuscorectangulata*, new species; b, *A. vestalis* (Zeller); c, *A. manaznitae* Keifer; d, *Stenoma mistrella* Busck; e, *S. crambitella* Walsingham; f, *Setiostoma xanthobasis* Zeller.

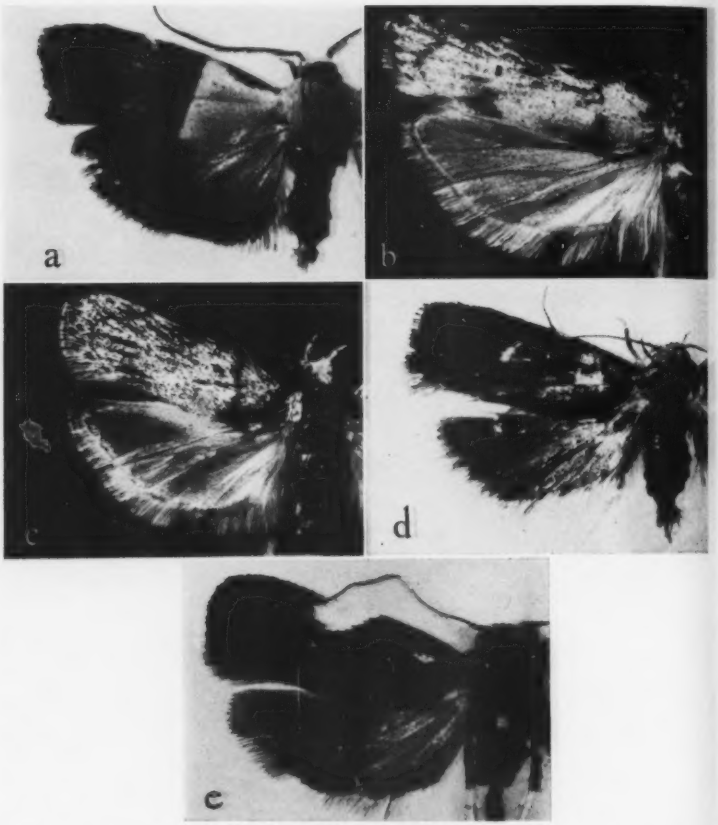
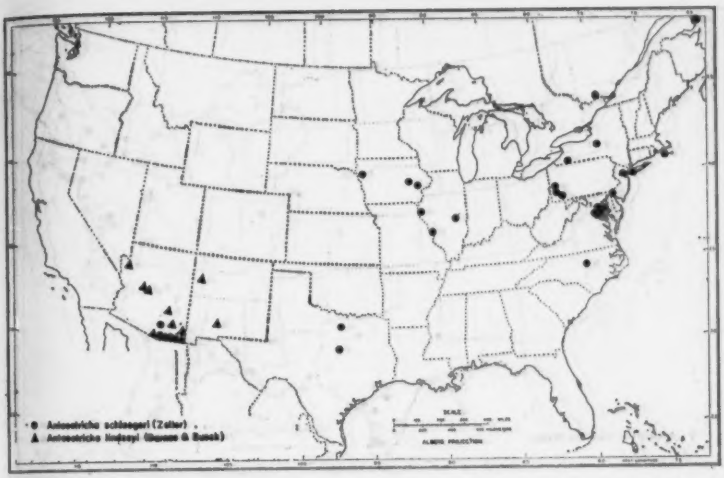
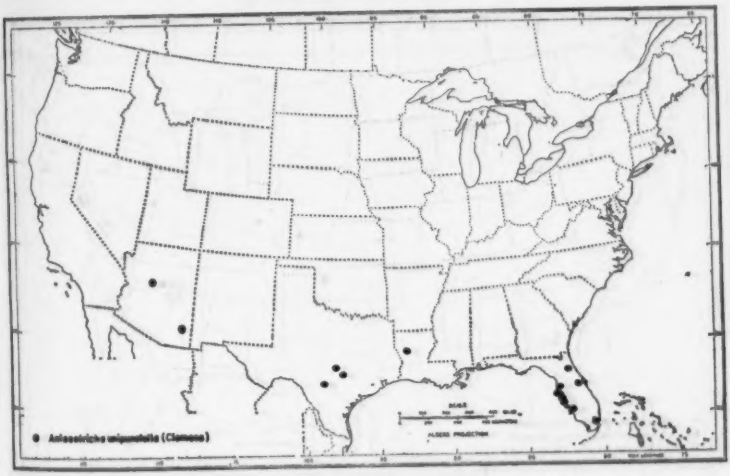


PLATE 4.—a, *Setiostoma fernaldella* Riley; b, *Mothonica kimballi*, new species; c, *Menestomorpha oblongata* Walsingham; d, *Menesta tortriciformella* Clemens; e, *M. melanella* Murtfeldt.



MAP 1.—Distribution of *Antaeotricha schlaegeri* (Zeller) and *A. lindseyi* (Barnes and Busck).



MAP 2.—Distribution of *Antaeotricha unipunctella* (Clemens).

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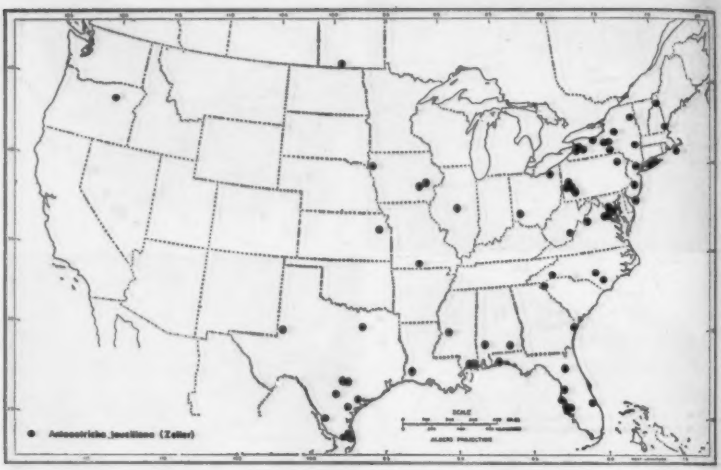
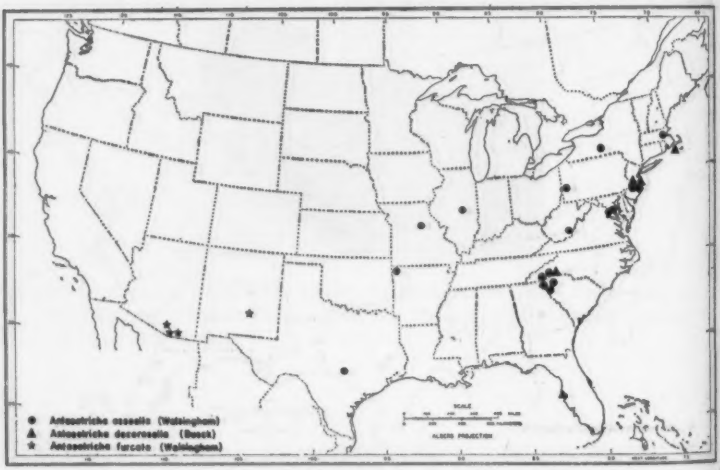
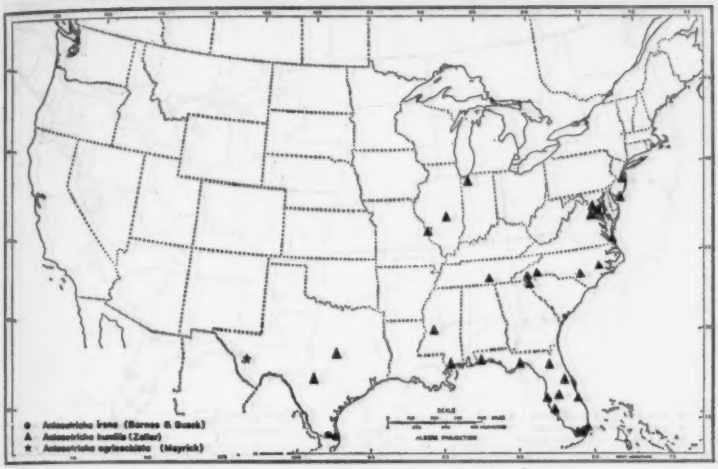


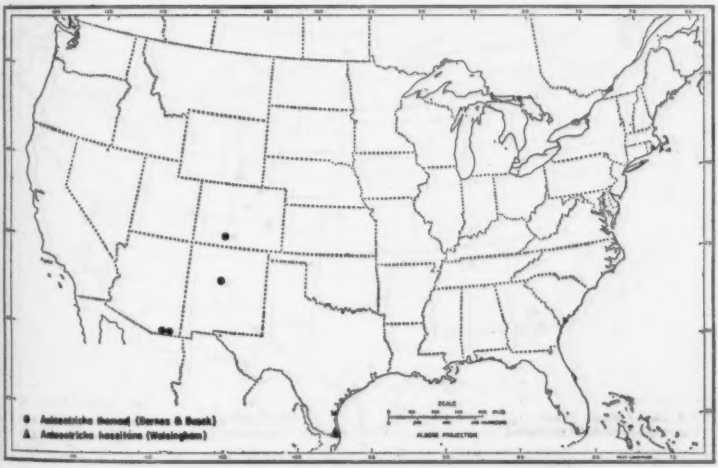
MAP 3.—Distribution of *Antaeotricha leucillana* (Zeller).



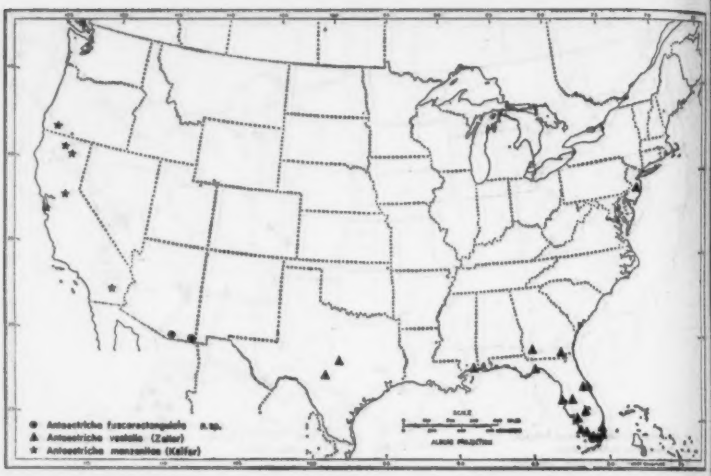
MAP 4.—Distribution of *Antaeotricha osseella* (Walsingham), *A. decorosella* (Busck), and *A. furcata* (Walsingham).



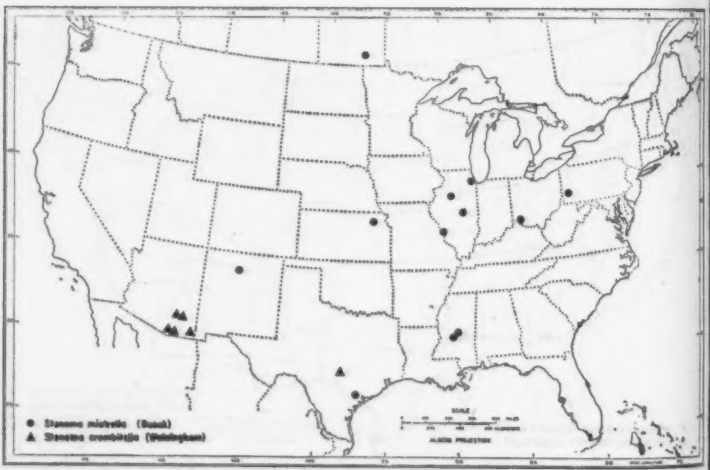
MAP 5.—Distribution of *Antaeotricha irene* (Barnes and Busck), *A. humilis* (Zeller), and *A. agrioschista* (Meyrick).



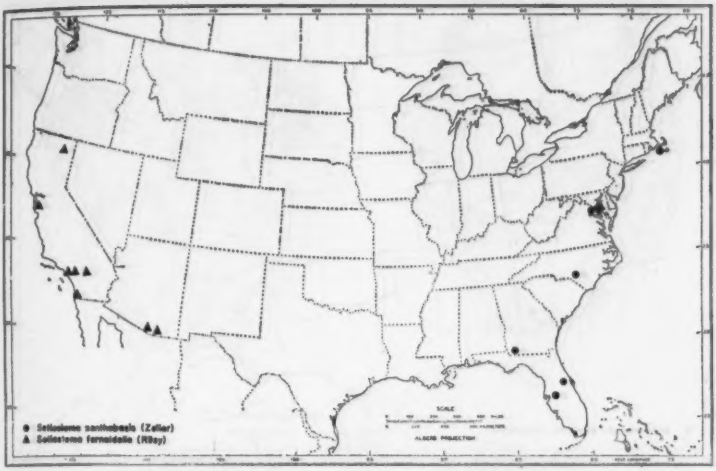
MAP 6.—Distribution of *Antaeotricha thomasi* (Barnes and Busck) and *A. haesitans* (Walsingham).



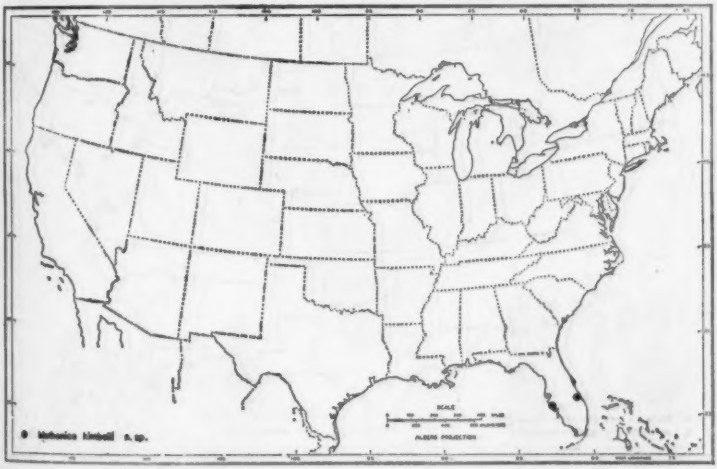
MAP 7.—Distribution of *Antaeotricha fuscorectangulata*, new species, *A. vestalis* (Zeller), and *A. manzanitae* (Keifer).



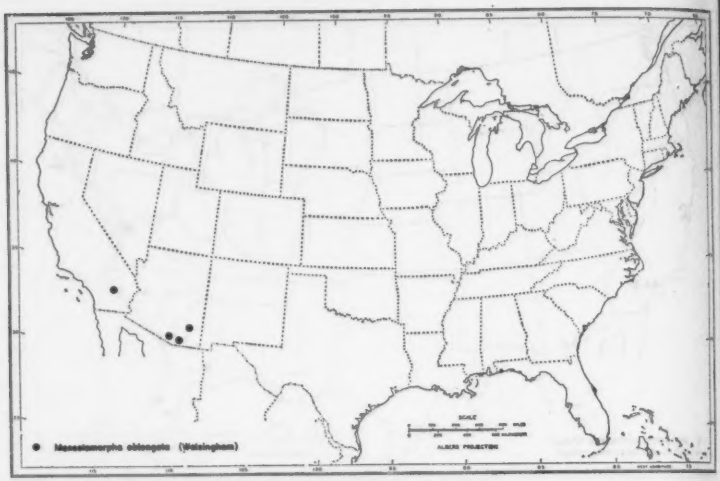
MAP 8.—Distribution of *Stenoma mistrella* (Busck) and *S. crambitella* (Walsingham).



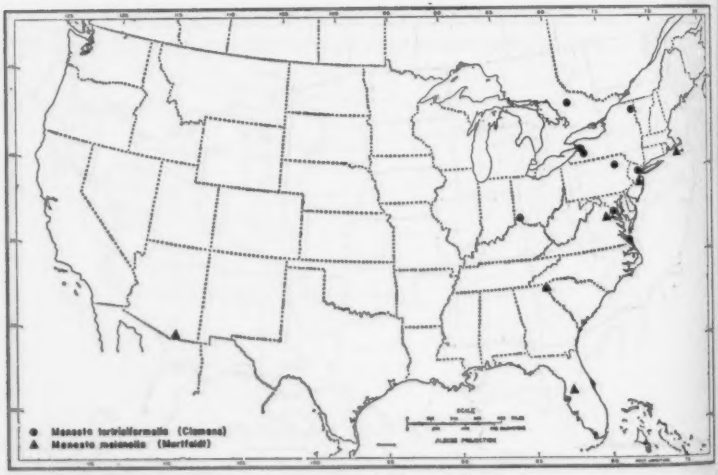
MAP 9.—Distribution of *Setiostoma xanthobasis* (Zeller) and *S. fernaldella* (Riley).



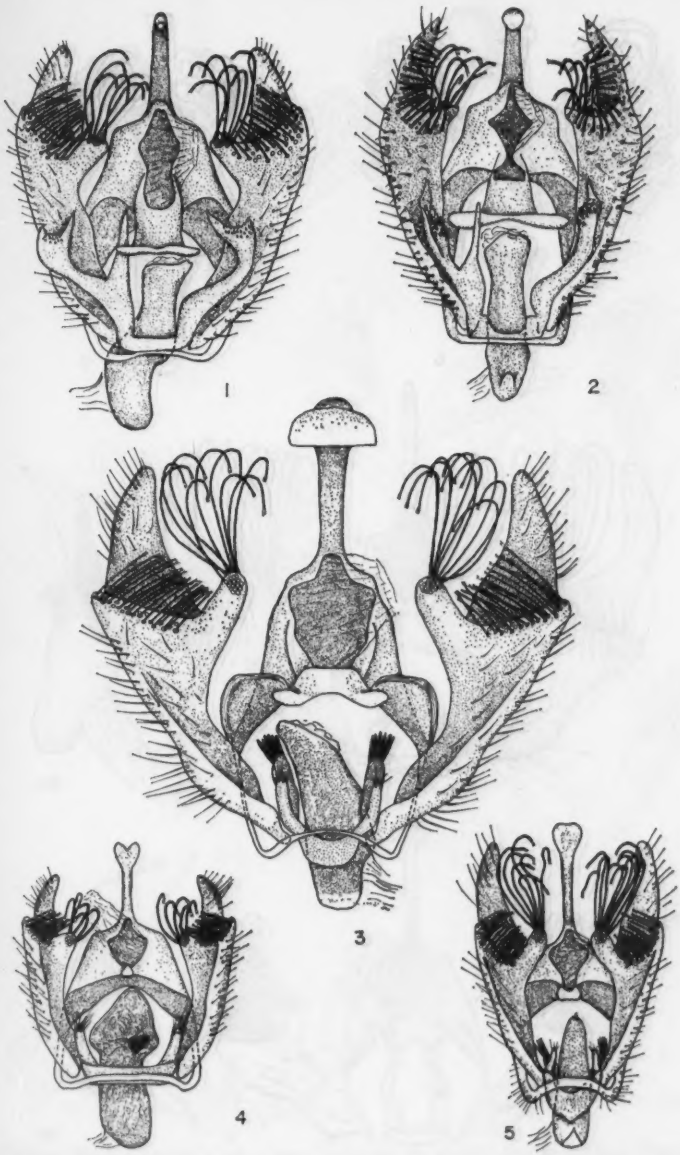
MAP 10.—Distribution of *Mothonica kimballi*, new species.



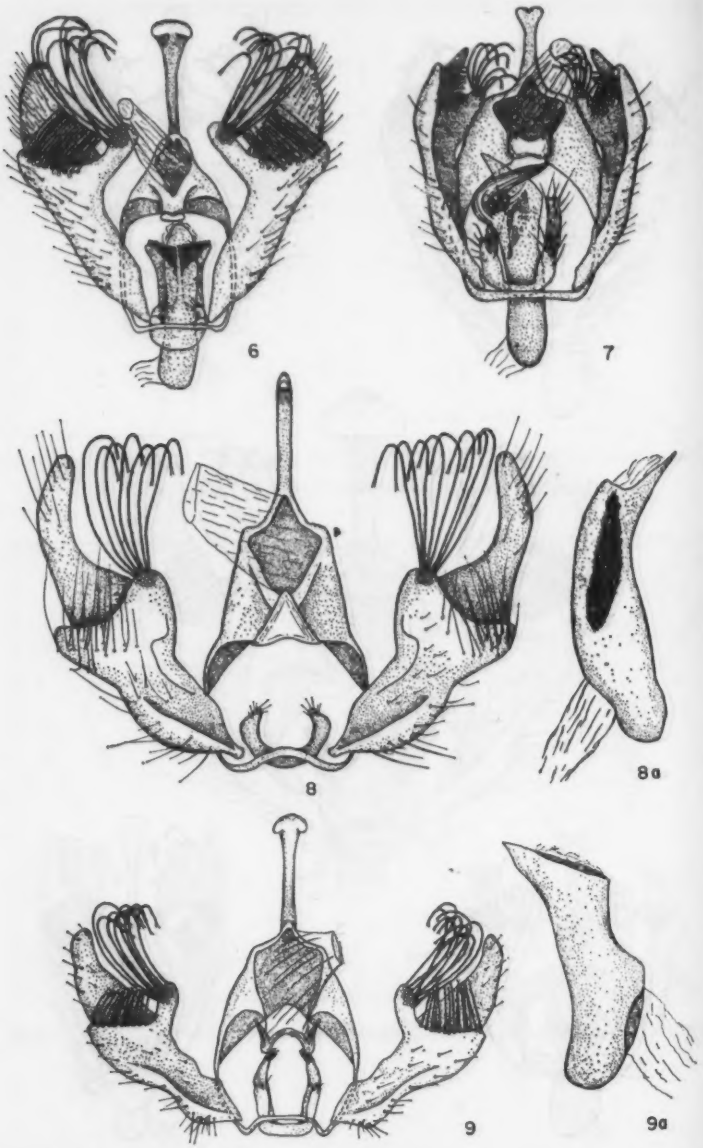
MAP 11.—Distribution of *Menestomorpha oblongata* (Walsingham).



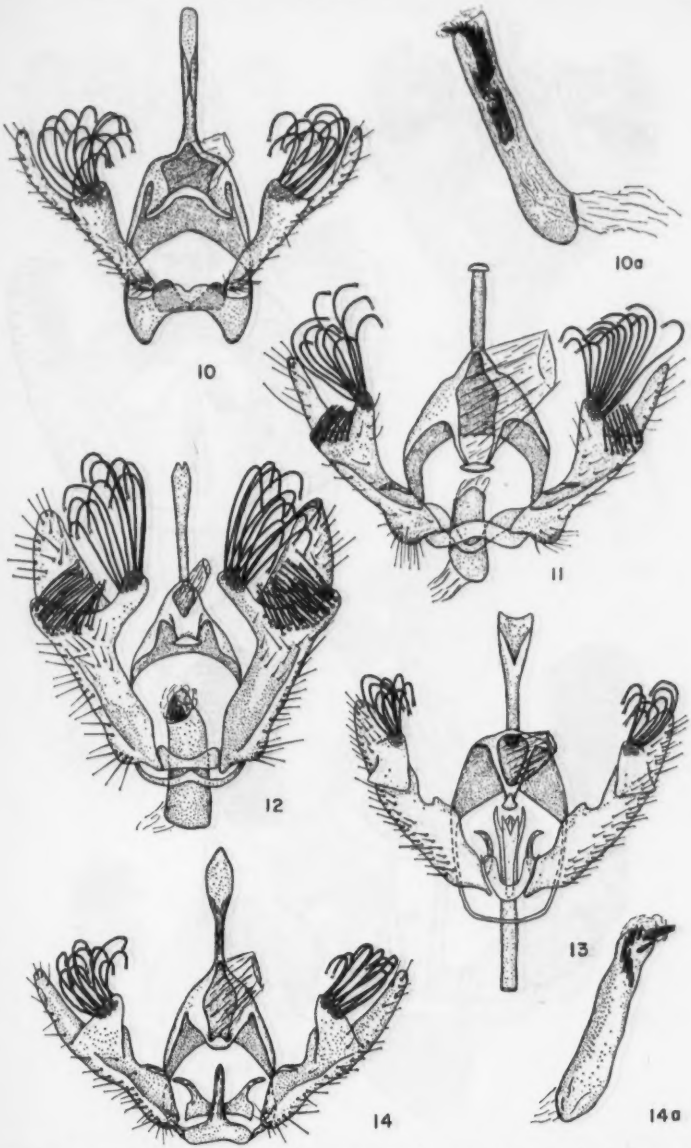
MAP 12.—Distribution of *Menesta tortriciformella* (Clemens) and *M. melanella* (Murtfeldt).



FIGURES 1–5.—Ventral view of male genitalia: 1, *Antaeotricha schlaegeri* (Zeller); 2, *A. lindseyi* (Barnes and Busck); 3, *A. unipunctella* (Clemens); 4, *A. leucillana* (Zeller); 5, *A. osseella* (Walsingham).



FIGURES 6–9.—Ventral view of male genitalia: 6, *Antaeotricha decorosella* (Busck); 7, *A. furcata* (Walsingham); 8, *A. irene* (Barnes and Busck); 9, *A. vestalis* (Zeller). Lateral view of aedeagus: 8a, *A. irene;* 9a, *A. vestalis.*



FIGURES 10–14.—Ventral view of male genitalia: 10, *Antaeotricha agrioschista* (Meyrick); 11, *A. humilis* (Zeller); 12, *A. thomasi* (Barnes and Busck); 13, *A. haesitans* (Walsingham); 14, *A. fuscorectangulata*, new species. Lateral view of aedeagus: 10a, *A. agrioschista;* 14a, *A. fuscorectangulata.*

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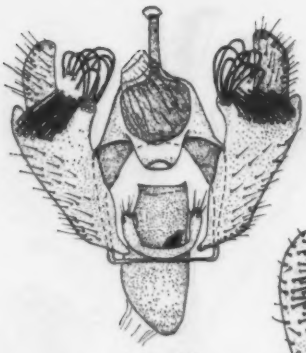

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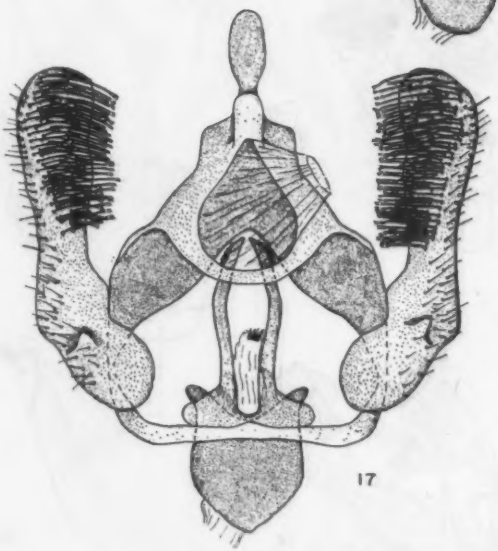

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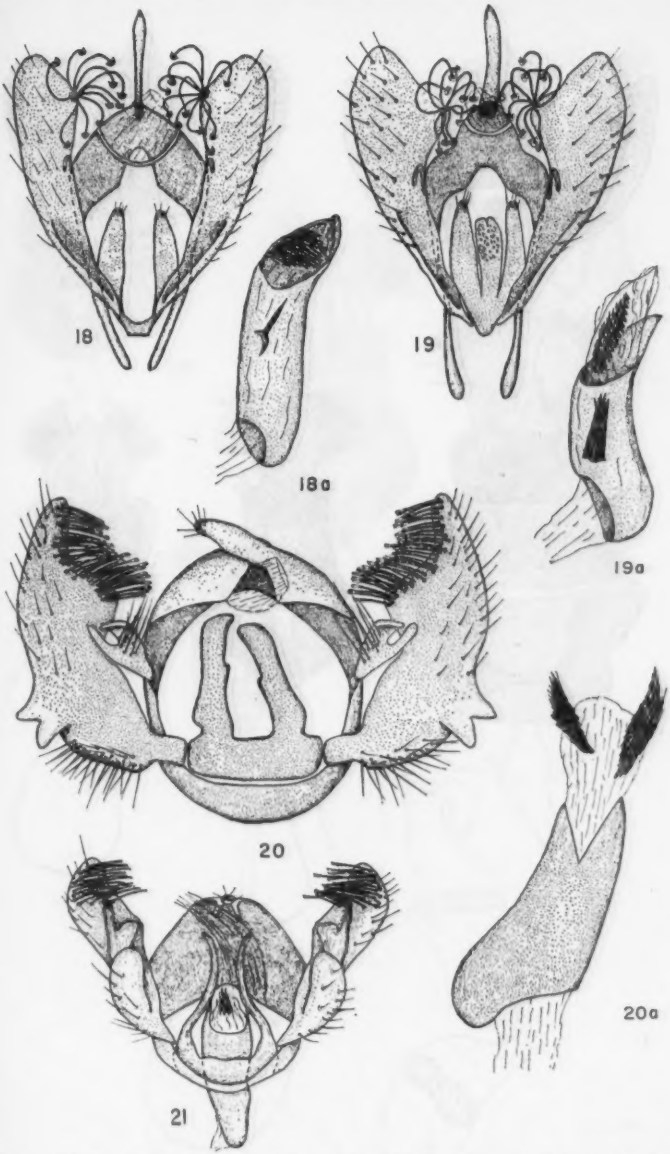
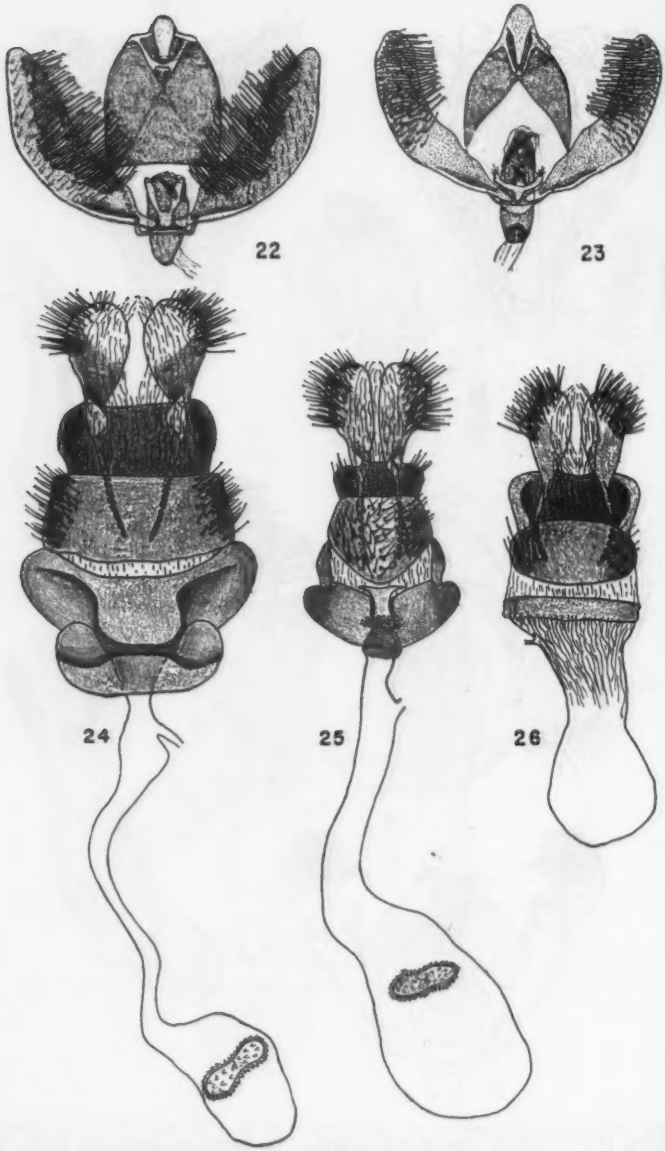
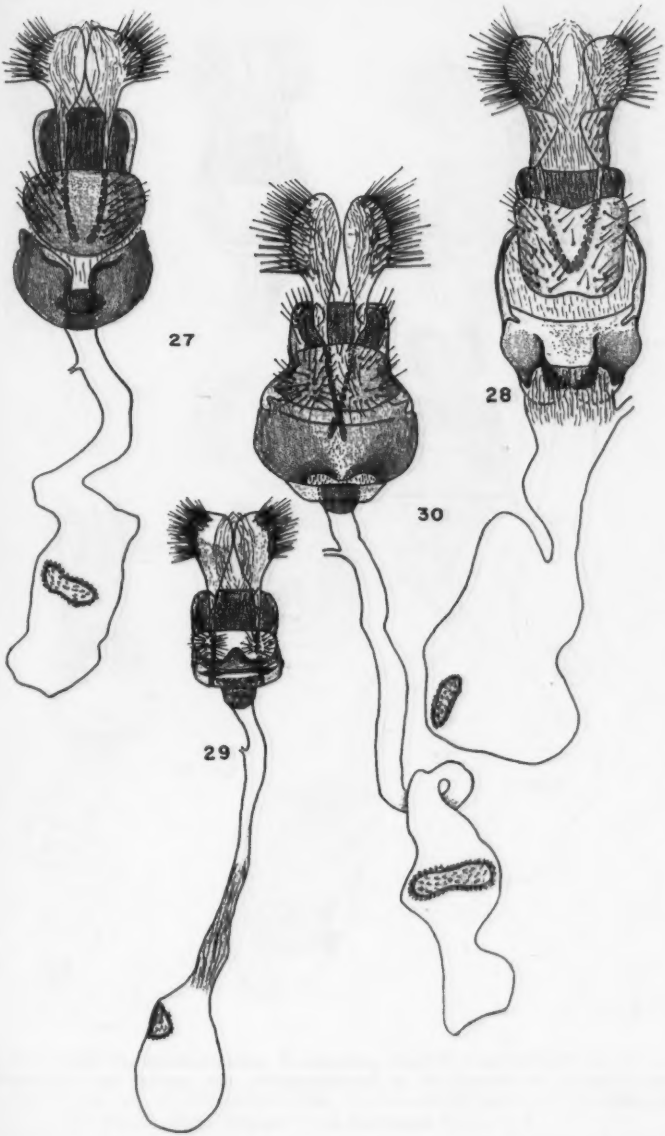
FIGURES 15–17.—Ventral view of male genitalia: 15, *Antaeotricha manzanitae* Keifer; 16, *Stenoma mistrella* Busck; 17, *S. crambitella* Walsingham.



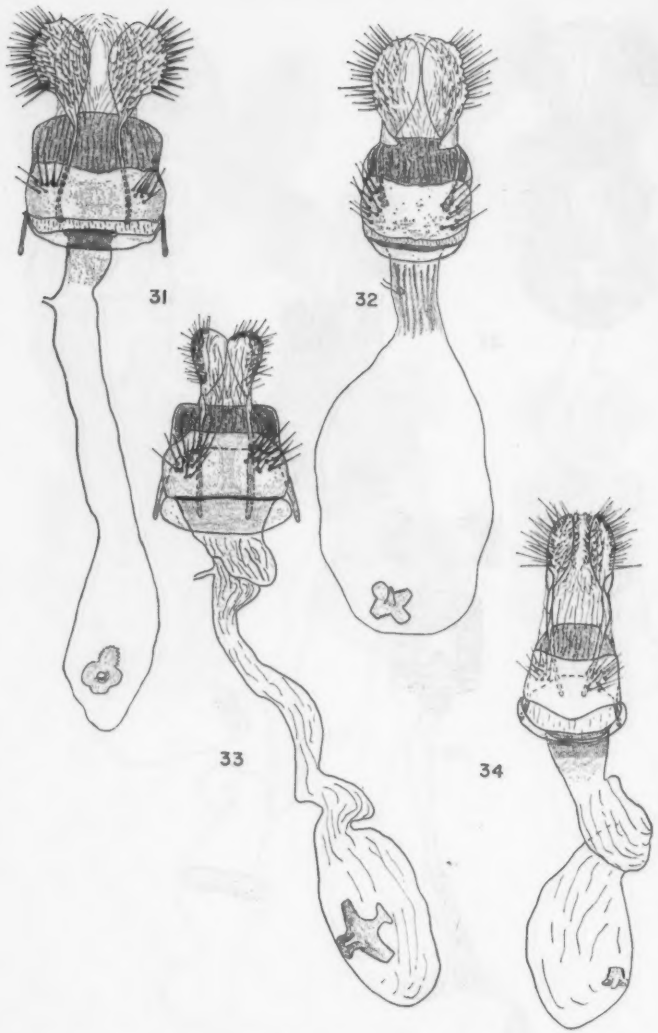
FIGURES 18–21.—Ventral view of male genitalia: 18, *Setiostoma xanthobasis* Zeller; 19, *S. fernaldella* Riley; 20, *Mothonica kimballi*, new species; 21, *Menestomorpha oblongata* Walsingham. Lateral view of aedeagus: 18a, *S. xanthobasis;* 19a, *S. fernaldella;* 20a, *M. kimballi.*



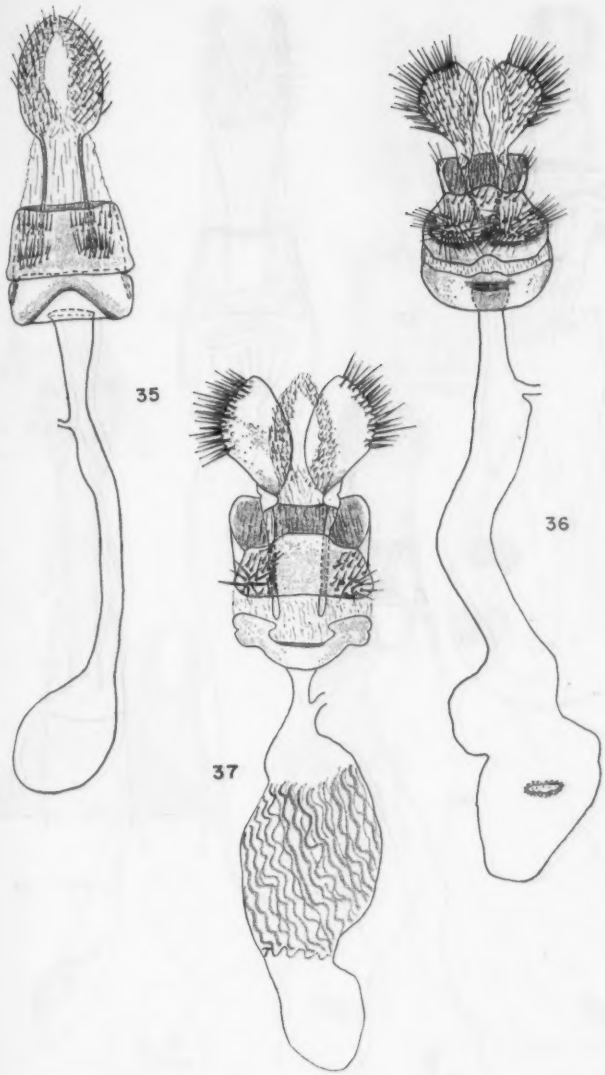
FIGURES 22–26.—Ventral view of male genitalia: 22, *Menesta melanella* Murtfeldt; 23, *M. tortriciformella* Clemens. Ventral view of female genitalia: 24, *Antaeotricha schlaegeri* (Zeller); 25, *A. unipunctella* (Clemens); 26, *A. leucillana* (Zeller).



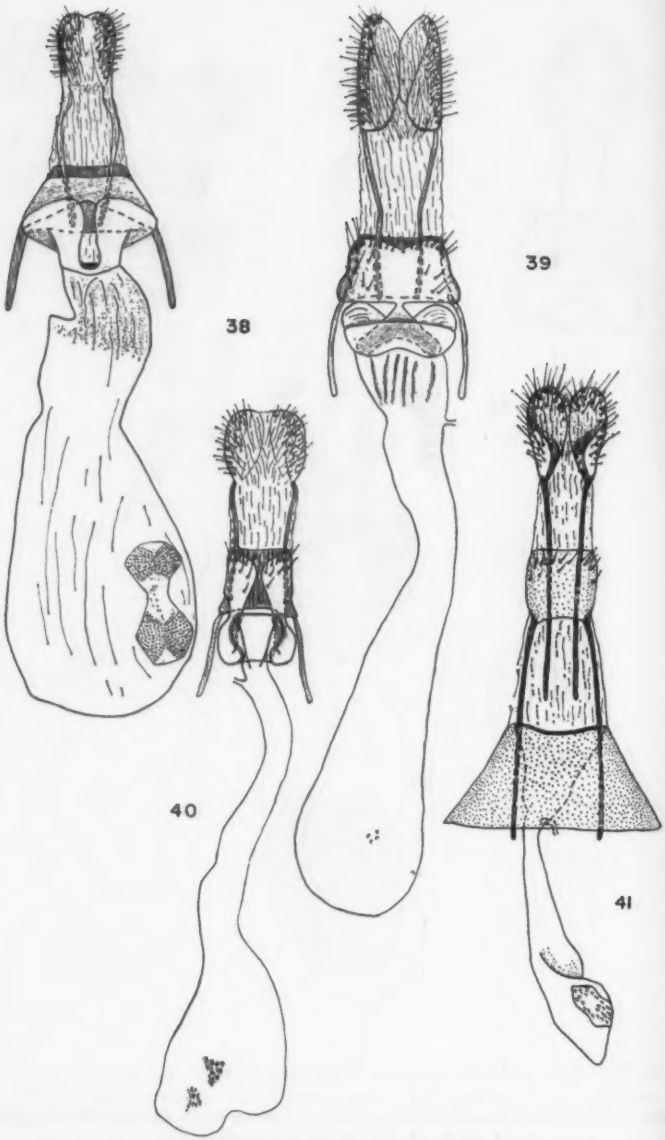
FIGURES 27–30.—Ventral view of female genitalia: 27, *Antaeotricha ossella* (Walsingham); 28, *A. furcata* (Walsingham); 29, *A. irene* (Barnes and Busck); 30, *A. decorosella* (Busck).



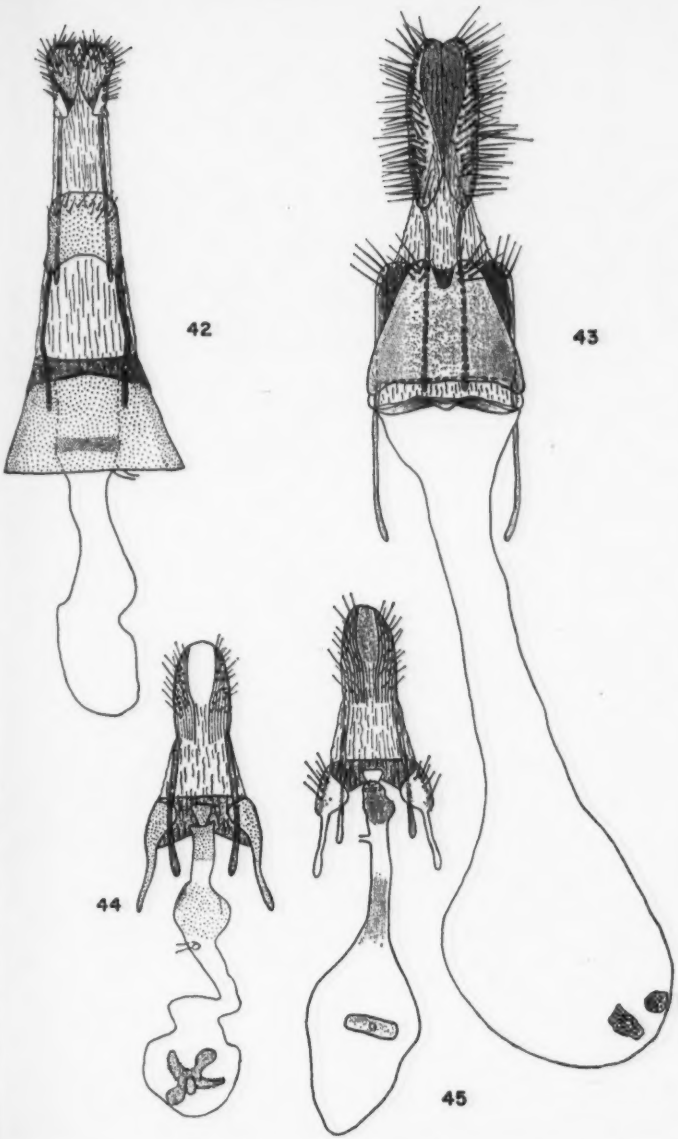
FIGURES 31–34.—Ventral view of female genitalia: 31, *Antaeotricha humilis* (Zeller); 32, *A. thomasi* (Barnes and Busck); 33, *A. fuscorectangulata*, new species; 34, *A. agrioschista* (Meyrick).



FIGURES 35–37.—Ventral view of female genitalia: 35, *Antaeotricha haesitans* (Walsingham); 36, *A. vestalis* (Zeller); 37, *A. manzanitae* Keifer.



FIGURES 38–41.—Ventral view of female genitalia: 38, *Mothonica kimballi*, new species; 39, *Stenoma mistrella* Busck; 40, *S. crambitella* Walsingham; 41, *Setiostoma xanthobasis* Zeller.



FIGURES 42–45.—Ventral view of female genitalia: 42, *Setiostoma fernaldella* Riley; 43, *Menestomorpha oblongata* Walsingham; 44, *Menesta tortriciformella* Clemens; 45, *M. melanella* Murtfeldt.

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A SURVEY OF VERTEBRAL NUMBERS IN SHARKS

By VICTOR G. SPRINGER *and* J. A. F. GARRICK

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Volume 116 1964 Number 3496

A SURVEY OF VERTEBRAL NUMBERS IN SHARKS[1]

By Victor G. Springer and J. A. F. Garrick

Introduction

This paper broadly surveys vertebral numbers in sharks. The study was prompted by our discovery that vertebral numbers are important systematic characters in those carcharinid shark genera that we have been investigating (Springer, 1964; Garrick, in ms). We, therefore, have undertaken to determine if vertebral numbers are of similar value in other genera, with the hope that some contribution might be made to shark classification as a whole.

Vertebral numbers have not been used previously as a systematic character in sharks although they have received some attention in rays (Ishiyama, 1958) and have been widely employed in teleosts (e.g., Bailey and Gosline, 1955; Schmidt, 1917). The vertebral numbers from sharks that have been recorded in the literature are given either without comment or comparison or are employed as data for studies in morphology or intraspecific variation (Punnett, 1904; Aasen, 1961).

We present here vertebral data on 1524 specimens. We personally made counts from 858 of these, mostly by X-ray methods. The

[1] This study was conducted on funds administered by Dr. Leonard P. Schultz and provided by contracts between the Office of Naval Research (NONR 1354(09)), the Atomic Energy Commission (AEC AT(30-1)-2009), and the Smithsonian Institution.

remaining 666 counts are from the literature or were supplied by colleagues. The 1524 specimens pertain to 70 of the approximately 80 genera of sharks and to 135 of the approximately 300 species. Because our purpose has been to survey, our coverage within individual species is far from complete, but considerable attention has been paid to a few species that have presented problems.

We wish to express our gratitude to the officials of the following institutions for their assistance in providing specimens and X-ray facilities.

ANSP—Academy of Natural Sciences of Philadelphia
BMNH—British Museum (Natural History), London
CAS—California Academy of Sciences, San Francisco
CM—Canterbury Museum, Christchurch, New Zealand
CNHM—Chicago Natural History Museum
DMNZ—Dominion Museum, Wellington, New Zealand
GVF—George Vanderbilt Foundation, Stanford University, California
IRSN—Institut Royal des Sciences Naturelles de Belgique, Brussels
ISZZ—Institut für Spezielle Zoologie und Zoologisches Museum, Berlin
MCSN—Museo Civico di Storia Naturale, Genoa, Italy
MCZ—Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
RNH—Rijksmuseum van Natuurlijke Historie, Leiden, Holland
SIO—Scripps Institution of Oceanography, La Jolla, California
SU—Division of Systematic Biology, Stanford University, California
TGFC—Texas Game and Fish Commission Marine Laboratory, Rockport
UBC—University of British Columbia, Vancouver
UMML—University of Miami Institute of Marine Sciences, Miami, Florida
UMMZ—University of Michigan Museum of Zoology, Ann Arbor
USNM—United States National Museum, Washington, D.C.
UZMK—Universitetets Zoologiske Museum, Copenhagen, Denmark

J. G. Casey, Bureau of Sport Fisheries, Sandy Hook Marine Laboratory, kindly provided some vertebral counts of *Alopias superciliosus* and *Isurus oxyrinchus*, and H. Heyamoto, Bureau of Commercial Fisheries, Seattle, Washington, sent us ten specimens of *Squalus acanthias* taken from off the coast of Washington. W. I. Follett of the California Academy of Sciences, San Francisco, generously allowed us to use his and J. D. Hopkirk's vertebral counts of *Cetorhinus maximus* and *Carcharodon carcharias*. These counts were made on vertebral columns in the CAS collections. We are grateful to Sheldon Applegate, formerly of Duke University, for providing us with counts from New Jersey and Delaware specimens of *Carcharias taurus*, and to Elvira Siccardi, Faculty of Natural Sciences of Buenos Aires, Argentina, for counts on *Isurus oxyrinchus*, *Carcharodon carcharias*, and *Lamna nasus*.

Our identifications of the species of *Sphyrna* are the result of unpublished studies by Dr. Carter R. Gilbert, to whom we extend our appreciation for allowing us to use his characterizations.

Drs. Bruce B. Collette, Carl L. Hubbs, W. Ralph Taylor, and S. J. Weitzman read the manuscript and made valuable suggestions for its improvement.

Methods

Sharks ranging in size from small embryos to specimens several feet long were used in the survey. Radiographs were made with a hard-ray machine and various industrial X-ray films. The finest-grained films gave the most desirable results, but generally grain size was a limiting factor only in making counts of the terminal vertebrae in the caudal fin. A few counts were made on skeletons. Each vertebral count was separated into two parts:

1. Precaudal vertebral count (P) includes all complete centra anterior to the forward edge of the upper precaudal pit, or, in species where a pit is absent, all complete centra anterior to the origin of the upper lobe of the caudal fin.

2. Caudal vertebral count (C) includes all centra posterior to the precaudal vertebrae.

In order to demarcate clearly the precaudal from caudal centra on a radiograph, a pin was inserted at the forward edge of the upper precaudal pit, or at the upper caudal origin, so that its point touched the vertebral column. In some sharks, notably species of *Brachaelurus*, *Halaelurus*, and *Hemiscyllium*, it is impossible to decide the point of origin of the dorsal lobe of the caudal fin; for these sharks, only total counts (T) are given.

We do not know if our two methods of separating precaudal from caudal vertebrae produce homologus (hence comparative) counts in sharks with and without precaudal pits; however, the value of the methods lies in their usefulness and for the purposes of this study we consider the results homologous. Another possible way of subdividing the vertebral column would be into monospondylous and diplospondylous centra.[2] The transition from monospondyly (anterior) to diplospondyly (posterior) usually occurs above the pelvic fin, but there are notable exceptions (*Etmopterus* and a few species of *Carcharhinus*) wherein it is much further posterior. The transition usually is evidenced by an abrupt reduction in centrum length (pl. 1A, B)[3] but in several species, e.g., *Alopias superciliosus* (pl. 1C), *Scoliodon laticaudus*, *Prionace glauca*, the reduction is so slight as to be unnoticeable on a radiograph.

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[1] Monospondyly=one centrum per myomere; diplospondyly=two centra per myomere. For detailed discussion, see Goodrich, 1930, pp. 26-27.

[2] We have not made dissections to confirm the transition points from monospondyly to diplospondyly but accept the first notably shorter centrum above or behind the pelvic region as the first diplospondylous centrum. Confirmation of this view is found in some radiographs wherein it is possible to see the apertures for nerve roots issuing: one pair for each centrum in the monospondylous region and one pair for two centra in the diplospondylous region.

Precaudal vertebral counts are subject to a maximum error of plus or minus two vertebrae. It is not always possible to decide accurately from a radiograph which is the first vertebra because, at the rear of the head, other structures, including the occipital condyles, mask the front of the vertebral column. Occasionally, owing to the angle at which our marking pin had entered, we had some doubt as to the last precaudal vertebra. Most of the counts given here were made by each of us working independently but using the same radiographs. The exceptions to these counts are the counts of the carcharhinid genera on which we are working individually. We never differed by more than one in our precaudal counts and we arbitrarily report the even count, appropriately compensating for the caudal count.

At the tip of the caudal fin the last few centra of most shark species are frequently too small to give good resolution on radiographs. Sometimes there was a difference of as much as three or four vertebrae in our counts of the caudal section. In such counts one determination or the other has been listed arbitrarily. Because of the range of variation in counts within a single species and because of the high number of vertebrae in most sharks, we believe that such an error is hardly significant. Generally, the precaudal count is more consistent than the caudal count. Caudal counts were made under magnification, usually with a low-power binocular microscope.

The number of precaudal vertebrae is established early in embryos, but the last caudal vertebrae usually are not fully formed until late in embryonic life; hence, only late-stage embryos provide caudal counts comparable to those of adults. In those embryos in which we found calcification incomplete, we give a minimal count for the caudal vertebrae (>). We doubt that more than 25 additional vertebrae would have been formed in any of the embryos we examined, and we believe that in most of the embryos the number of yet unformed vertebrae would be much fewer.

Complete calcification of the column is recognizable on radiographs by the posterior extent reached by the column (to within a short distance of the tip of the tail) or by uniform density of the images of the last several centra.

We counted apparent fusions between centra (and also apparent monospondylous intrusions in regions of diplospondyly) as single centra, but we recorded separately the recognizable centra when the fusion was obviously incomplete.

In most sharks the monospondylous centra gradually increase in length from the cranium posteriorly, so that the centra are usually longest at, or near, the region where diplospondyly begins. The difference in the length of anterior and posterior monospondylous centra may be small or great. The difference in length between the

posterior monospondylous centra and the anterior diplospondylous centra is similarly variable though reasonably constant for any one species.

Reporting these relative centrum lengths is obviously of value but offers difficulties. Because many of the specimens we used were curled or distorted, radiographs of them show oblique images of some centra. The degree of obliqueness may vary from one region of the vertebral column to another; we, therefore, see the likelihood of introducing considerable error by giving dimensions of centra that are not adjacent to, or at least very close to, each other on the radiograph. For this reason, we do not report the length of anterior relative to posterior monospondylous centra. To compare the length of a posterior monospondylous centrum with that of an anterior diplospondylous centrum (thereby indicating the relative prominence of the transition point between monospondyly and diplospondyly), we measured the length of the penultimate monospondylous centrum and the first diplospondylous centrum and then obtained a ratio, listed as "A" in the results and tables, by dividing the length of the former by the length of the latter and multiplying by 100. We chose the penultimate monospondylous centrum because it is usually more representative of the posterior monospondylous centra (the ultimate monospondylous centrum is often reduced in length even though noticeably longer than the first diplospondylous centrum). The first diplospondylous centrum was chosen because there is often a regular alternation of centrum length in the diplospondylous region. In deciding the transition point from monospondyly to diplospondyly when differences in length of the centra bordered on being imperceptible, we may be in error occasionally though we think that any error thus introduced is slight.

To give an indication of centrum shape, we have divided the length of the penultimate monospondylous centrum by its diameter (appearing as height or width on the radiograph) and have multiplied this ratio by 100 to yield the values listed as "B" in the results and tables.

Results

Our data on shark vertebrae are reported in table 1. Table 2 condenses these data so that the subordinal, familial, and generic limits, but not those of the individual species, can be more easily visualized.

We have representative samplings of six of the seven suborders of sharks and a partial sampling of the seventh. None of these suborders can be distinguished on its vertebral counts alone. In terms of total number of vertebrae we found a range of from 60 to about 419. The lowest total count is for *Squaliolus laticaudus* and the highest for

Alopias vulpinus. The species with the lowest precaudal count (44) is *Squaliolus laticaudus* and the one with the highest (149) is *Prionace glauca*. The lowest count (13) of caudal vertebrae is for *Euprotomicrus bispinatus*, *Squaliolus laticaudus*, and *Squaliolus sarmenti*, and the highest (>298) is for *Alopias vulpinus*.

Compared with the other suborders, the Squaloidea have low vertebral counts. In all recent systems of classification the Squaloidea are regarded as relatively advanced, so there is some justification for regarding their low counts as an advanced feature. On this basis, within the Squaloidea we could consider the generally lower counts of the dalatiids as indicating that they are more advanced than the squalids. The Notidanoidea and the Heterodontoidea, which, on other features, have some claim to being representative of the ancestral or primitive sharks, do not have more vertebrae than do many of the so-called advanced sharks in the Galeoidea. This may merely indicate that median numbers are most primitive, with both decrease and increase as specialized conditions.

Only one family, the Alopiidae, with one genus, *Alopias*, is recognizable on its vertebral numbers alone. The distinctiveness of *Alopias* is due to the high number of vertebrae in its tail, a feature that might be expected from the extreme length of its tail compared to other sharks. The diagnostic value of vertebral numbers increases in the lower taxa. Thus, in the families containing several genera, a few genera (*Lamna* in the Lamnidae, *Brachaelurus* and *Stegostoma* in the Orectolobidae, *Conoporoderma* and *Atelomycterus* in the Scyliorhinidae, *Prionace* in the Carcharhinidae, and perhaps others) are clearly recognizable on precaudal, caudal, or total count. Of the genera containing two or more species, almost half include at least one species distinguishable on vertebral counts. Because of our incomplete coverage, we believe it premature to list these species here.

The suborders Squaloidea, Pristiophoroidea, Squatinoidea, and Heterodontoidea are consistent in having fewer caudal than precaudal vertebrae. In the suborder Galeoidea, the families Scyliorhinidae, Triakidae, and most of the Orectolobidae show the same trend. It may be of significance that the sharks with fewer precaudal than caudal vertebrae are for the most part small, and usually bottom-dwelling. In *Carcharhinus* (Garrick, in ms.), the large species tend to have fewer caudal than precaudal vertebrae and the small species have more caudal than precaudal vertebrae.

In our studies, particularly of the genera *Carcharhinus*, *Scoliodon*, *Loxodon*, and *Rhizoprionodon* (Garrick, in ms.; Springer, 1964), we have noted no sexual dimorphism in vertebral numbers; however, Punnett (1904), who dissected 567 specimens of *Etmopterus spinax*

from Norway, reported a statistically significant difference between males and females in numbers of monospondylous ("whole vertebrae") and diplospondylous ("half vertebrae") centra and in total number of segments (counting each whole vertebra or each two half vertebrae as one segment). Females had the higher average in each of these three categories but in none did the average difference exceed half a unit. Using Punnett's figures (for adults and embryos) we have plotted frequency distributions of total vertebrae (each whole or half vertebra of Punnett equals one vertebra in our study) and averaged them:

Total vertebrae	81	82	83	84	85	86	87	88	89	90	91	*Average*
Males	4	14	41	51	63	39	19	9	3	2	–	84.73
Females	3	12	39	71	84	55	33	20	3	–	2	85.02

A t test of these data gives the value 2.06, which is not significant at the 95 percent level; however, a t test of the number of monospondylous vertebrae of adults gives a value which is significant above the 99.1 percent level. Punnett did not allow for possible year-class differences and it is not possible to tell from his data if there is bias. A study of sexual differences in vertebral counts based on embryos of a single year class would offer a solution to this problem.

If the nature of sexual dimorphism in vertebral counts of sharks is generally of the magnitude shown by *E. spinax*, it is not surprising that our counts, based on small numbers of specimens, do not indicate it.

The A values $\left(\frac{\text{length penultimate monospondylous centrum}}{\text{length first diplospondylous centrum}} \times 100\right)$, like the vertebral numbers, vary widely within families and genera but within the species are relatively constant. The A values are smallest in the Lamnidae, Alopiidae, Triakidae, Carcharhinidae, and Sphyrnidae. The A values, up to about 300, are greatest in the Carcharhinidae, a family with great variation in this proportion. Families containing some species with A values of about 200 include the Scapanohynchidae, Triakidae, Sphyrnidae, Squalidae and Dalatiidae.

The B values $\left(\frac{\text{length penultimate monospondylous centrum}}{\text{diameter of penultimate monospondylous centrum}} \times 100\right)$ are in general as inconsistent within the families and genera as are the A values. The range of the B values is from about 25 (*Alopias* spp.) to 200 (*Isistius brasiliensis*).

If a B value of 75 or less is arbitrarily considered low and one of 125 or more is considered high, 13 of the 18 large sharks (attaining a size of over six feet) for which we have data are indicated as having low B values. Small species may have either high or low B values, but of the 30 species of sharks having high B values, only one, the

unique *Scapanorhynchus owstoni*, attains a size greater than six feet. These facts seem to indicate that B values are functionally significant in terms of total length attained by the species.

Remarks Concerning Certain Species

In *Hexanchus* and *Notorhynchus* the vertebrae are not sufficiently calcified to produce an image on a radiograph. In *Heptranchias*, the precaudal vertebrae are poorly calcified and there is considerable spacing between the images on the radiograph, which probably indicates that only the center or the ends of each centrum are registered. The caudal vertebrae are well calcified but terminate abruptly at about the level of the subterminal caudal notch in each specimen, a condition not noted in any other species we examined.

In *Chlamydoselachus anguineus* only some of the vertebrae are calcified; hence, total counts could not be made. In one specimen the anterior 16 and posterior 3 precaudal centra and a few anterior caudal centra were apparent; in the other specimen radiographed, the anterior 18 and posterior 9 precaudal centra and the anterior 20 caudal centra were apparent Goodey (1910) indicated the number of vertebrae in a specimen he dissected to be 112, on the basis of the number of neuromeres, which were determined by counting the ventral-root foramina of the spinal nerves perforating the basidorsals. We believe that counting in this manner yields a figure which is much too low, for it does not take into account the diplospondylous condition. It is also obvious from Goodey's plates that no nerve roots issue from large segments of the vertebral column.

Aasen (1961) reported vertebral counts of 60 specimens of *Lamna nasus* from the western North Atlantic, as follows:

Total vertebrae	150	151	152	153	154	155	156	157	158	159	160	161
Specimens	1	1	5	6	9	8	9	7	8	1	4	1

He noted that the number of precaudal vertebrae ranged from 83 to 89.

One specimen of *Paragaleus gruveli* (USNM 196158) examined (pl. 1A) had two separated groups of elongated (monospondylous) centra in the precaudal region. If each of these elongated centra were counted as two, the number of precaudal centra would be 77 and the total count 147, which would be more in accord with the other specimen examined from the same locality.

Specimens of *Sphyrna tiburo* from Florida have much lower vertebral counts than specimens from other localities. Counts from large numbers of specimens throughout the Atlantic and Pacific range of this species should be made to determine the significance of the counts shown by the Florida specimens.

FIGURE A: Embryo of *Paragalaxias gruveli* (USNM 196158), a species with a precaudal pit. Caret indicates point of separation of monospondylous from diplospondylous centra above anterior third of pelvic fin. This species is characterized by high A and B values (see text). Note two interpolated groups of monospondylous centra in diplospondylous region. Pin separates caudal from precaudal vertebrae. FIGURE B: *Eimopterus pusillus* (USNM 157835), a species without a precaudal pit. Caret indicates point of separation of monospondylous from diplospondylous centra in region far posterior to pelvic fin. This species is characterized by high A and B values (see text). Pin separates caudal from precaudal vertebrae. FIGURE C: Embryo of *Alepias vulpinus* (CNHM 52100), a species with a precaudal pit. This species is characterized by a low A value and a very low B value (see text). Transition point from monospondylous to diplospondylous centra occurs in region above pelvic fin but is not clear on figure. Pin separates caudal from precaudal vertebrae.

Squalus acanthias is considered a circumglobally distributed species in the temperate waters of both the northern and southern hemispheres although it is reported infrequently from subtropical areas. Our evidence (table 1) indicates that at least in the northern hemisphere the Atlantic population (with 79–85 precaudal vertebrae in 7 specimens) and the Pacific population (with 68–76 precaudal vertebrae in 21 specimens) have differentiated. Six specimens from the southern hemisphere have 75–78 precaudal vertebrae and thus are intermediate between the northern hemisphere populations. A large-scale study of vertebral numbers in this species might yield interesting information on speciation.

On the basis of the counts obtained for *Centrophorus uyato*, there is evidence that differences occur in the populations from the Gulf of Mexico and the eastern Atlantic. More counts will be necessary to verify this indication.

The genus *Etmopterus* is distinct from all other shark genera examined in consistently having the last monospondylous centrum at a point behind the tip of the pelvic fin (pl. 1B), usually under the anterior portion of the second dorsal fin. In all other sharks we have investigated, except a few species of *Carcharhinus* (Garrick, in ms.), the last monospondylous vertebra occurs over the pelvic fin, usually over the pelvic base.

Punnett (1904) reported the total vertebral counts of 163 free-living females of *Etmopterus spinax*. Twenty-five were gravid and were reported with the counts of their respective embryos (see our table 3). Examination of Punnett's data shows that the average number of vertebrae in a litter exceeds the maternal count in 10 of the 13 mothers with 82–85 vertebrae but is less than the maternal count in the 12 mothers with 86–88 vertebrae. Differences in counts from a single litter range from two to seven vertebrae. We have found a similar variation in the range of vertebral counts in carcharhinid sharks in the few cases in which we have mothers with embryos.

Only late-stage embryos of *Echinorhinus cookei* and *E. brucus* were radiographed; the radiographs show no evidence of calcification of the centra.

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TABLE 1.—*Vertebral characters in sharks*

P=precaudal vertebrae. C=caudal vertebrae. T=total vertebrae. A=length of penultimate monospondylous centrum divided by length of first diplospondylous centrum × 100. B=length of penultimate monospondylous centrum divided by its width ×100.

Family, genus, species, locality	P	C	T	A	B
HEXANCHIDAE					
Hexanchus					
H. griseum (Bonnaterre) (see discussion)	uncalcified				
MCSN 34580, Italy					
USNM 186120, Florida					
Notorhynchus					
N. maculatus Ayres (see discussion)	uncalcified				
USNM 27071, California					
USNM 61234, California					
USNM 38301, Peru					
USNM 87681, Uruguay					
Heptranchias					
H. perlo (Bonnaterre) (see discussion)					
MCSN 37507, Ligurian Sea, Mediterranean	ca. 85	45	ca. 130		
USNM 164167, south of Louisiana	90	56	146		
	89	52	141		
USNM 151972, off North Carolina	90	61	151		
CHLAMYDOSELACHIDAE					
Chlamydoselachus					
C. anguineus Garman (see discussion)			>112	(Goodey, 1910)	
USNM 48530, Japan					
USNM 161522, Japan					
HETERODONTIDAE					
Heterodontus					
H. francisci (Girard)					
USNM 34778, California	71	41	112	100	95
H. japonicus Dumeril					
USNM 71764, Japan	72	38	110	136	94
UMMZ 179075, Japan	74	42	116		
H. galeatus (Günther)					
USNM 59876, New South Wales, Australia	71	35	106	140	92
H. zebra (Gray)					
UMMZ 179077, locality unknown		41		133	89
CARCHARIIDAE					
Carcharias					
C. taurus Rafinesque					
USNM 143423, Louisiana, embryo	84	>70	>154		
Sandy Hook Bay, New Jersey (from Sheldon Applegate)	82	81	163		
	80	83	163		
	-	84	-		
	86	80	166		
	84	79	163		
	84	81	165		
	84	-	-		
1 mile off Lewes, Delaware (from Sheldon Applegate)	85	71	156		
	85	85	170		
	83	81	164		
	87	81	167		
SCAPANORHYNCHIDAE					
Scapanorhynchus					
S. owstoni (Jordan)					
MCZ 1279, Japan	53	69	122	180	172

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
LAMNIDAE					
Isurus					
I. oxyrinchus Rafinesque					
MCZ 37904, Bahamas, embryo	110	80	190	ca. 100	
New York-New Jersey (from J. G. Casey)	110	81	191		
	110	80	190		
	109	–	–		
Puerto Quequén, Argentina (from E. Siccardi)	110	86	196		
I. glaucus					
UMMZ 177116, Japan	108	79	187	127	8
SIO 50-240, California	112	80	192	120	8
I. species (Garrick, in ms.)					
USNM 197427, Indo-Pacific	112	83	195	128	8
USNM 197429, Indo-Pacific	111	86	197	130	9
Lamna					
L. nasus (Bonnaterre)					
BMNH 1961.11.2.1, English Channel	83	68	153	ca. 100	
Puerto Quequén, Argentina (from E. Siccardi)	91	71	162		
Locality unspecified (after Günther, 1870)	–	–	155		
Western North Atlantic (after Aasen, 1961)	84–89	–	150–161	(based on 60 specimens; see text remarks)	
Carcharodon					
C. carcharias (Linnaeus)					
CAS 26345, California	–	–	178		
CAS 26361, California	104	68	172		
CAS 26363, California	105	68	173		
CAS 26366, California	104	74	178		
CAS 26367, California	107	ca. 76	ca. 183		
CAS 26678, California	107	77	184		
CAS 26680, California	105	ca. 78	ca. 183		
CAS 26376, California	106	73	179		
CAS 26378, California	106	71	177		
CAS 26694, California	104	77	181		
CAS 26695, California	104	77	181		
CAS 26781, California	108	73	181		
CAS 26793, California	103	73	176		
CAS 27013, California	107	74	181		
CAS 27014, California	105	80	185		
CAS 27015, California	104	76	180		
Puerto Quequén, Argentina (from E. Siccardi)	104	83	187		
	105-	79	184		
CETORHINIDAE					
Cetorhinus					
C. maximus (Gunnerus)					
CAS 25873, California			110		
USNM (uncat.), off British Columbia	50	60	110		
ALOPIDAE					
Alopias					
A. superciliosus (Lowe)					
UMML 8861, Florida, two sibling embryos	102	180	282		
	102	187	289		
MCZ 36155, Cuba, embryo	102	181	283	ca. 100	
New York (from J. G. Casey)	102	193±3	295±3		
USNM 197700, California	100	204	304		
A. vulpinus (Bonnaterre)					
CNHM 52100, Formosa	121	>298	>419		
SIO 52-19, Galápagos, two sibling embryos	119	243	362	136	37
	119	240	359	127	35

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
ORECTOLOBIDAE					
Orectolobus					
O. maculatus (Bonnaterre)					
USNM 176695, near Brisbane, Australia	106	50	156	133	78
Stegostoma					
S. tigrinum (Bonnaterre)					
RNH skeleton no. 429, Java	81	145	226		
S. fasciatum (Hermann)					
USNM 138547, Macassar market, Celebes	95	122	217	150	55
USNM 138548, Macassar market, Celebes	101	121	222	140	58
Chiloscyllium					
C. indicum (Gmelin)					
UMMZ 179022, Japan	114	61	175	143	62
C. griseum Müller and Henle					
UMMZ 179034, Java			170	118	72
C. species					
USNM 6449, Hong Kong	111	61	172	115	71
C. species					
USNM 148107, Persian Gulf	104	65	169	117	74
USNM 148108, Persian Gulf	107	60	167	117	80
Eucrossorhinus					
E. dasypogon (Bleeker)					
BMNH 1867.11.28.209, Aru Islands, syntype of *Crossorhinus dasypogon* Bleeker	100	62	162		
Ginglymostoma					
G. cirratum (Bonnaterre)					
USNM 196159, Senegal, sibling embryos	97	77	174	125	80
	97	73	170	118	74
USNM 37741, Jamaica (sibling embryos?)	98	73	171	116	71
	95	75	170	121	74
USNM 181312, Sonora, Mexico	92	83	175	125	66
Hemiscyllium					
H. ocellatum (Bonnaterre)					
USNM 176863, Great Barrier Reef,			191	120	71
Queensland, Australia			190	150	75
H. species					
USNM 123025, no locality			192		
Brachaelurus					
B. waddi (Bloch and Schneider)					
USNM 197619, Sydney, Australia			142	125	68
RHINCODONTIDAE					
Rhincodon					
R. typus Smith					
TGFC, off Texas, embryo	81	>72	>153		
SCYLIORHINIDAE					
Cephaloscyllium					
C. uter (Jordan and Gilbert)					
USNM 196142, California	74	35	109	141	94
Galeus					
G. arae (Nichols)					
USNM 185602, off Nicaragua (Atlantic)	75	60	135	158	143
	76	>51	>127	173	124
USNM 159233, off Florida	74	55	129	141	124
USNM 158101, southwest of Grand Bahama Island	81	59	140	147	133
Haploblepharus					
H. edwardsi (Voigt)					
MCZ 1028, Cape St. Blaize, South Africa	94	43	137	140	107

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	
SCYLIORHINIDAE—Continued					
Halaelurus					
H. vincenti (Zietz)					
UBC 58-406, Adelaide, South Australia			130	133	114
Parmaturus					
P. xaniurus (Gilbert)					
MCZ 1002, off California	70	60	130	145	113
Apristurus					
A. herklotsi (Fowler)					
USNM 93134, Philippines, holotype of *Pentanchus herklotsi* Fowler	69	>50	>119	155	122
A. serwayi (Fowler)					
USNM 93135, Borneo, holotype of *Pentanchus serwayi* Fowler	70	46	116	130	112
Scyliorhinus					
S. torazame (Tanaka)					
UMMZ 179029, Fusan Market, Korea	74	38	112	107	101
S. garmani (Fowler)					
USNM 43749, East Indies, holotype of *Halaelurus garmani* Fowler	92	40	132	162	116
Pentanchus					
P. profundicolus Fowler					
USNM 70260, Mindanao Sea, holotype (several centra missing, counts estimated)	70	54	138	135	113
Cynoporoderma					
C. marleyi (Fowler)					
ANSP 53427, Natal, South Africa, holotype of *Poroderma marleyi* Fowler	76	28	104	172	100
Atelomycterus					
A. marmoratus (Bennett)					
UMMZ 179003, Java	110	54	164		
Undescribed genus and species (S. Springer, in ms.)					
USNM 185557, Caribbean Sea	105	40	145	125	116
PSEUDOTRIAKIDAE					
Pseudotriakis					
P. microdon Capello					
Cape Verde Is. (from Jaquet, 1905)			ca. 180		
TRIAKIDAE					
Scylliogaleus					
S. queketti Boulenger					
BMNH 1903.2.6.21, off Natal, South Africa, holotype	88	>52	>140	114	100
Triakis					
T. semifasciata Girard					
UMMZ 61055, California	84	52	136	142	117
T. scyllia Müller and Henle					
UMMZ 179099, Fusan Bay, Korea	93	60	153	200	98
	93	60	153	200	98
T. venusta (Tanaka)					
UMMZ 179005, Okinawa, Japan	107	51	158	144	100
T. henlei (Gill)					
UMMZ 61051, California	109	51	160	117	93
SU 34283, California	103	49	152	112	98
Eridacnis					
E. radcliffei Smith					
USNM 74604, Philippines, holotype	77	47	124	125	101

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
TRIAKIDAE—Continued					
Mustelus					
M. manazo Bleeker					
UMMZ 178990, Japan	90	52	142	136	120
UMMZ 178993, Japan	90	51	141	123	112
M. kanekonis (Tanaka)					
UMMZ 179007, locality unknown	81	49	130	153	104
M. canis (Mitchill)					
USNM 72091, New Jersey	90	56	146	137	111
M. canis or *M. schmitti* Springer					
USNM 86724, Uruguay	89	48	137	109	122
	90	46	136	144	121
M. norrisi Springer					
USNM 116444, Florida	93	52	145	137	100
M. higmani Springer and Lowe					
USNM 156030, off Surinam, holotype	88	49	137	132	102
USNM uncataloged, off British Guiana	89	50	139	131	100
USNM uncataloged, off Surinam	87	49	136	132	100
	90	51	141	134	105
	89	50	139	142	92
	91	53	144		
Triakoides					
T. obesus (Rüppell)					
ANSP 71738, Pearl and Hermes Reef, embryo	129	85	214	ca. 100	
Leptocharias					
L. smithi Müller and Henle					
USNM 164435, Liberia	137	76	213	112	68
MCZ 39091, off Banana, West Africa	136	75	211	ca. 100	
CARCHARHINIDAE					
Carcharhinus					
C. serrah (Valenciennes)					
9 specimens from China, Thailand, and Red Sea	66–73	85–93	153–166	142–167	88–107
C. limbatus (Valenciennes)					
5 specimens from Florida, Brazil, Virgin Islands, and Liberia	98–100	98–101	194–198	110–138	62–99
C. falciformis (Bibron)					
14 specimens from western north Atlantic and eastern North Pacific Oceans	98–105	98–110	199–215	112–123	69–78
C. leucas (Valenciennes)					
7 specimens from Florida, Lake Nicaragua, Guatemala, Tampico (Mexico), and Panama	110–114	95–104	208–218	110–130	60–72
C. melanopterus (Quoy and Gaimard)					
14 specimens from Gilbert, Caroline, and Philippine Islands and Thailand and Red Sea	115–122	86–92	202–214	112–126	64–74
Aprionodon					
A. isodon (Müller and Henle)					
USNM 118457, Texas	79	86	165	206	102
Negaprion					
N. brevirostris (Poey)					
CNHM 32743, Florida	117	84	201	125	76
Hypoprion					
H. macloti Müller and Henle					
IBZZ 5799, Hong Kong	70	84	154	222	154
SU 12988, Hong Kong	68	82	150	191	150
SU 14488, Burma	70	82	152	102	124
H. signatus Poey					
USNM 133827, Florida, embryo	104	80	184	120	67

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
CARCHARHINIDAE—Continued					
Rhizoprionodon (see Springer, 1964)					
Subgenus *Rhizoprionodon*					
R. acutus (Rüppell)					
121 specimens from the eastern Atlantic and Indo-Pacific; counts vary according to locality.	55–79	64–83	121–162		
R. terraenovae (Richardson)					
Counts based on 74 specimens from the western Atlantic from Nova Scotia to Yucatan. A and B values based on 6 specimens.	58–66	67–81	126–144	151–174	118–14
R. porosus (Poey)					
Counts based on 58 specimens from the western Atlantic from the Bahamas to Uruguay. A and B values based on 5 specimens.	66–75	69–85	136–159	125–141	109–11
R. longurio (Jordan and Gilbert)					
Counts based on 39 specimens from the eastern Pacific.	68–86	78–85	146–167		
Subgenus *Protozygaena*					
R. lalandei (Valenciennes)					
Counts based on 45 specimens from the western Atlantic from Panama to Brazil. A and B values based on two specimens.	79–90	67–79	153–168	130–138	96–10
R. oligolinx Springer					
Counts based on 57 specimens from the Indo-Pacific.	84–91	64–75	151–162	ca. 100	
R. taylori (Ogilby)					
Counts based on 10 specimens from Australia.	73–80	62–70	135–149	ca. 100	
Loxodon (see Springer, 1964)					
L. macrorhinus Müller and Henle					
Counts based on 20 specimens, vary with locality; A and B values based on 4 specimens	77–106	71–86	148–191	112–208	84–11
Scoliodon (see Springer, 1964)					
S. laticaudus Müller and Henle					
Counts based on 98 specimens; A value based on 4 specimens	97–112	50–62	148–171	ca. 100	
Prionace					
P. glauca (Linnaeus)					
BMNH 1961.11.2.2, English Channel	140	98	247	ca. 100	
USNM 48317, Italy	143	96	239		
USNM 125700, off northern (eastern?) United States	142	101	243		
USNM 164621–23, Hawaii, sibling embryos	146	106	252	110	8
	146	102	248		
	145	102	247		
UMMZ (field no. H29–15), Japan	147	>90	>237		
USNM 197687, Capetown, South Africa	143	101	244		
Galeorhinus					
G. galeus (Linnaeus)					
UZMK 463, locality unknown	83	53	136		
G. japonicus (Müller and Henle)					
UMMZ 179081, Fukuoka market, Japan	106	54	160	114	8
Hemipristis					
H. elongatus (Klunzinger)					
GVF 2385–1, Gulf of Thailand	104	86	190		
	104	90	194	122	8
	103	89	192	122	6
Galeocerdo					
G. cuvieri (Peron and LeSueur)					
GVF 2357–1, Gulf of Thailand	105	126	231	113	5
USNM 196524, Florida, sibling embryos	106	>117	>223	133	6
	108	>114	>222		

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
CARCHARHINIDAE—Continued					
Nasogaleus					
N. macrostoma (Bleeker)					
BMNH 1867.11.28.197, Java, holotype of *Hemigaleus macrostoma* Bleeker	74	63	137	129	141
N. microstoma (Bleeker)					
BMNH 1867.11.28.173, Java, holotype of *Hemigaleus microstoma* Bleeker	81	69	150	148	108
UMMZ 179017, Java	78	65	143		
Paragaleus					
P. gruveli Budker					
USNM 196188, Senegal, embryo (see discussion)	72	70	142	180	140
USNM 196163, Senegal, embryo (see discussion)	79	70	149	192	144
P. pectoralis (Garman)					
MCZ 847, off New England (?), holotype of *Hemigaleus pectoralis* Garman	78	70	148	174	119
SPHYRNIDAE					
Sphyrna					
S. tiburo (Linnaeus)					
USNM 88677, Guayaquil, Equador	81	82	163	158	106
USNM 190591, Panama Bay, Panama			165	146	111
ANSP 86208, San Miguel Bay, Panama	86	87	173	125	89
ANSP 581, Rhode Island	88	82	170	127	93
USNM 125763, Appalachicola Bay, Florida	72	70	142	105	132
USNM 116888, Tortugas, Florida	72	71	143	153	124
USNM 104318, Recife, Brazil	80	78	158	143	111
S. media Springer					
USNM 196140, Gulf of Nicoya, Costa Rica	103	92	195	136	73
	100	93	193	120	69
	103	89	192		
	102	88	190	111	80
	101	92	193	113	65
	102	92	194	120	72
USNM 190593, Panama Bay, Panama	102	94	196	113	63
	102	91	193		
	101	92	193	116	73
	101	91	192	105	72
S. mokarran (Rüppell)					
USNM 29645, Mazatlan, Mexico	98	108	206	137	69
USNM 40026, New South Wales, Australia, embryo	97	108	205	122	78
S. lewini (Griffith)					
USNM 72476, Java, embyro	93	105	198	156	91
USNM 130604, Foochow, China	92	100	192	148	83
USNM 29999, Jamaica	96	108	204		
USNM 25180, South Carolina	89	85	174	155	99
S. zygaena (Linnaeus)					
UMMZ 179078, Japan	99	103	202	121	82
USNM 119699, Virginia	102	104	206	ca. 100	
S. tudes (Valenciennes)					
USNM 195657, Mississippi	107	95	202	ca. 100	
S. blochi (Cuvier)					
RNH skeleton no. 343, Java	52	64	116		
CNHM 21836, North Borneo	54	70	124	178	138
USNM 195846, Bombay, India	52	66	118	160	133

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
SQUALIDAE					
Squalus					
S. acanthias					
USNM 17405, Norway	83	26	109	179	86
	83	26	109	191	75
CNHM 35495-7, Scotland	81	30	111	169	93
	85	30	115	223	97
	84	29	113	173	104
USNM 75055, Virginia	85	32	117	140	104
USNM 121955, Virginia	79	29	108	118	114
USNM 197602, Capetown, South Africa	75	27	102		
USNM 104828, Alaska	70	29	99	135	103
	73	30	103	162	96
USNM 52852, Alaska	71	29	100	141	109
USNM 27305, Puget Sound, Washington	70	30	100	155	124
USNM 50089, Puget Sound, Washington	69	28	97	141	119
USNM 197796, Washington	73	30	103		
	70	29	99		
	71	26	97		
	73	27	99		
	70	30	100		
	75	29	104		
	72	29	101		
	73	31	104		
	76	30	106		
	72	28	100		
USNM 71835, Japan	68	28	96	131	97
	69	29	98	167	109
	72	28	100	135	109
CNHM 50947, Japan	70	28	98	130	101
UMMZ 179056, Korea	69	29	98	148	107
	71	28	99	172	105
USNM 164430, Chile	78	31	109	175	121
	77	30	107	150	126
USNM 164431, Chile	76	26	102	170	121
USNM 77306, Straits of Magellan	78	29	105	148	127
	73	31	106	151	109
S. blainvillei (Risso)					
USNM 130611, Ningapo, Chekiang, China	86	28	114	128	90
UMMZ 179055, Japan	89	29	118	156	89
USNM 196545, Taiwan	89	27	116	156	95
CNHM 55618, Korea	89	27	116	106	81
USNM 197363, Hawaiian Islands	84	29	113	129	117
USNM 157864, Florida	87	28	115	152	93
	85	30	115	155	99
USNM 160631, Florida	86	29	115	140	96
USNM 157748, Florida	86	30	116	150	81
USNM 158478, Louisiana	86	31	117	143	93
USNM 197691, Capetown, South Africa	82	32	117		
MCSN 34458, Italy	80	26	106	160	109
USNM 28473 (presumably Italy)	78	28	106	155	102
	79	28	108	165	94
S. megalops (Macleay)					
GVF HK95 south China Sea	80	25	105		
	78	26	104		
	78				
USNM 191180, Taiwan	81	26	107	160	109
	83	26	108	136	94
	81	27	108	165	98
UMMZ 179033, Japan	80	26	106	136	97
UMMZ, 179063, Japan	79	27	106	144	92

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
SQUALIDAE—Continued					
Squalus—Continued					
S. cubensis Howell-Rivero					
USNM 157853, north of Cuba	84	30	114	150	80
USNM 157846, north of Cuba	86	30	116	141	100
USNM 196544, north of Cuba	87	29	116	144	92
USNM 164247, Dominican Republic	82	30	112		
Centrophorus					
C. uyato (Rafinesque)					
USNM 196160, Senegal	90	32	122	136	95
USNM 157862, south of Alabama	82	31	113		
	83	30	113		
C. squamosus (Bonnaterre)					
USNM 161517-18, Japan	82	24	106		
	83	24	107	125	78
MCZ 40769, New Zealand	86	28	114	122	109
Centroscymnus					
C. owstoni Garman					
UMMZ 142885, Japan	74	28	102	125	60
C. crepidater Bocage and Capello					
USNM 196151, Senegal	77	29	106	137	128
MCZ 40768, New Zealand, embryo, uncalcified					
C. coelolepis Bocage and Capello					
USNM 38072, off New Jersey	78	27	105	133	80
MCZ 37420, east of New York	79	26	105	126	67
MCZ 37424, east of New York	79	29	108	122	65
USNM 94522, Madeira	75	34	109	125	118
Centroscyllium					
C. fabricii (Reinhardt)					
USNM 131383, off Newfoundland	66	29	95	162	130
USNM 38110, off New York	67	30	97	200	122
C. ritteri Jordan and Fowler					
UMMZ 170024, off Japan	62	28	90	141	124
USNM 161521, Japan	61	27	88	181	106
	64	27	91	161	119
	64	26	90	160	121
Deania					
D. elegans Springer					
USNM 159608, off North Carolina, holotype	85	34	19	133	80
D. calcea (Lowe)					
UMMZ 142284, Japan	90	36	126		
Etmopterus					
E. polli Bigelow, Schroeder, and Springer					
USNM 163370, off Angola	54	24	78	144	163
E. spinax (Linnaeus)					
USNM 195848, Italy	55	29	84	120	118
Counts based on 567 specimens from Norway (after Punnett, 1904; see our discussion)			81-91		
E. virens Bigelow, Schroeder, and Springer					
USNM 158406, Gulf of Campeche, Mexico	56	27	83	173	173
USNM 185600, Nicaragua (Atlantic)	57	24	81	144	144
	57	24	81	140	140
	58	26	84	150	150
E. schultzi Bigelow, Schroeder, and Springer					
USNM 158144, south of Alabama	56	26	82	160	120
	57	25	82	153	153
	56	26	82	143	133
	58	24	82	147	147
	56	27	83	143	165

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
SQUALIDAE—Continued					
Etmopterus—Continued					
E. princeps Collett					
USNM 163365, off New Jersey	58	23	81	211	136
E. lucifer Jordan and Snyder					
USNM 51282, Japan	59	26	85	154	176
	62	27	89	152	173
USNM 161515, Japan	63	27	90		
E. bullisi Bigelow and Schroeder					
USNM 185597, northeast of Honduras	60	24	84	175	131
	61	24	85	178	114
USNM 185603, North Carolina	60	24	84	150	150
E. baxteri Garrick					
MCZ 40688, New Zealand	61	27	88	141	135
E. pusillus Lowe					
USNM 157835, off northwest Florida	64	24	88	154	180
E. frontimaculatus Pietschmann					
USNM 196521, Japan	66	22	88	127	136
UNMZ 179025, Japan	61				
OXYNOTIDAE					
Oxynotus					
O. centrina (Linnaeus)					
ANSP 575-76 Italy	61	30	91	143	95
	64	30	94		
DALATIIDAE					
Dalatias					
D. licha (Bonnaterre)					
MCSN 34631, Italy	51	27	78	140	156
MCZ 910, Italy	51	28	79	143	152
USNM 157844, south of Alabama	50	28	78	153	149
Scymnodalatias					
S. sherwoodi (Archey)					
CM no number, New Zealand, holotype of *Scymnodon sherwoodi* Archey	58	23	81	130	152
Euprotomicrus					
E. bispinatus (Quoy and Gaimard)					
USNM 190031, near Midway Island	51	13	64	182	190
USNM 164176, west of Johnston Island	47	14	61	173	161
USNM 190032, south Pacific Ocean	46	15	61	130	144
CAS 20431, off California (after Hubbs and McHugh, 1951)	48				
Heteroscymnoides					
H. marleyi Fowler					
ANSP 53046, South Africa, holotype	52	18	70	160	145
Isistius					
I. brasiliensis (Quoy and Gaimard)					
USNM 164174, west of Christmas Island	61	24	85	157	147
USNM 164175, northwest of Fanning Island	61	25	86	150	161
USNM 190039, near Fanning Island	60	24	84	166	200
USNM uncataloged, off Mississippi (Oregon 2507)	62	20	82	172	172
USNM uncataloged, off Mississippi (Oregon 2945)	61	20	81	159	189
	66	23	89	162	179
I. species (Garrick and S. Springer, in ms.)					
USNM uncataloged, off Mississippi (Oregon 3102)	65	27	92	167	180

TABLE 1.—*Vertebral characters in sharks*—Continued

Family, genus, species, locality	P	C	T	A	B
DALATHDAE—Continued					
Squaliolus					
S. sarmenti Noronja					
ANSP 2454, Madeira	48	13	61	139	178
S. laticaudus Smith and Radcliffe					
USNM 70259, Luzon, Philippines, holotype	47	13	60	173	173
USNM 76679, Luzon, Philippines, paratype	44			150	150
Somniosus					
S. rostratus Capello					
IRSN 1399c, Mediterranean	58	20	78		
ECHINORHINIDAE					
Echinorhinus (see discussion)					
E. cookei Pietschmann					
USNM 179805, Hawaii, embryos					
E. brucus (Bonnaterre)					
BMNH 1891.7.2.3.1, Nice, embryo					
PRISTIOPHORIDAE					
Pristiophorus					
P. schroederi Springer and Bullis					
UMMZ 178848, off Cuba	100	55	155	144	100
P. owenii Günther					
BMNH 1859.9.11.1, locality unknown, holotype	103	48	151	150	78
P. japonicus Günther					
BMNH 1862.11.1.37, Japan, syntype	109	40	149	114	83
BMNH no number, Japan, syntype	104	53	157		
UMMZ 176819, Japan	108	48	156	143	75
P. nudipinnis Günther					
BMNH 1869.2.24.2, Tasmania, syntype	103	50	153	117	99
Pliotrema					
P. warreni Regan					
BMNH 1905.6.8.9, Natal, South Africa, holotype	106	49	155	121	83
SQUATINIDAE					
Squatina					
S. japonica Bleeker					
UMMZ 179041, Nagasaki market, Japan	92	34	126	133	70
S. squatina (Linnaeus)					
IRSN 1401B, Mediterranean	93	28	121		
RNH skeleton no. 492, Holland	96				
RNH skeleton no. 428, no locality	93				
S. californica Ayres					
UBC 59-237, Cape San Lucas, Baja	108	33	141	135	56
California, Mexico	108	32	140	135	53

TABLE 2.—*Summary of vertebral characters in suborders, families, and genera of sharks*

For explanation of symbols, see table 1

	P	C	T	A	B
NOTIDANOIDEA					
Hexanchidae					
Hexanchus			uncalcified		
Notorhynchus			uncalcified		
Heptranchias	85–90	45–61	ca. 130–151		
CHLAMYDOSELACHOIDEA					
Chlamydoselachidae					
Chlamydoselachus			>112		
HETERODONTOIDEA					
Heterodontidae					
Heterodontus	71–74	35–42	105–116	133–160	89–96
GALEOIDEA	50–149	28–>298	104–>419	ca. 100–328	25–172
Carcharhinidae					
Carcharias	80–87	71–85	156–170		
Scapanorhynchidae					
Scapanorhynchus	53	60	122	180	172
Lamnidae	84–112	66–86	150–197	ca. 100–130	53–67
Isurus	106–112	79–86	187–197	100–130	53–67
Lamna	84–91	66–71	150–162	ca. 100	
Carcharodon	103–108	66–83	172–187		
Cetorhinidae					
Cetorhinus	50	60	110		
Alopiidae					
Alopias	100–121	180–>298	282–>419	ca. 100–136	25–27
Orectolobidae	81–114	50–145	142–226	115–150	55–90
Orectolobus	106	50	156	133	75
Stegostoma	81–101	121–145	217–226	140–150	55–58
Chiloscyllium	104–114	60–65	167–175	115–143	63–80
Eucrossorhinus	100	62	162		
Ginglymostoma	92–98	73–83	170–175	116–125	66–80
Hemiscyllium			190–192	120–150	71–75
Brachaelurus			142	125	66
Rhincodontidae					
Rhincodon	81	>72	>153		
Scyliorhinidae	69–110	28–60	104–164	133–173	94–140
Cephaloscyllium	74	35	109	141	94
Galeus	74–81	>51–60	>127–140	141–173	124–140
Haploblepharus	94	43	137	140	107
Holaelurus			130	133	114
Parmaturus	70	60	130	145	115
Apristurus	69–70	46–>50	116–>119	139–155	122–133
Scyliorhinus	74–92	38–40	112–132	162–167	105
Pentanchus	79	54	133	135	113
Conoporoderma	76	28	104	172	100
Atelomycterus	110	54	164		
Undescribed genus (S. Springer, in ms.)	105	40	145	125	125
Pseudotriakidae					
Pseudotriakis (from Jaquet, 1905)			ca. 156		
Triakidae	77–137	46–85	124–214	ca. 100–200	68–122
Scylliogaleus	88	>52	>140	114	103
Triakis	84–109	49–60	136–160	112–200	83–117
Eridacnis	77	47	124	125	105
Mustelus	81–93	46–56	130–146	123–169	93–122
Triaenodon	129	85	214	ca. 100	
Leptocharias	136–137	75–76	211–213	ca. 100–112	68

TABLE 2.—*Summary of vetebral characters in suborders, families, and genera of sharks*—Continued

For explanation of symbols, see table 1

	P	C	T	A	B
GALEOIDEA—Continued					
Carcharhinidae	54-149	50-126	110-252	ca. 100-328	38-154
Carcharhinus (Garrick, in ms.)*	54-125	53-110	110-235	110-328	60-107
Agrionodon	79	86	165	206	150
Negaprion	117	84	201	125	76
Hypoprion	70-104	80-86	153-184	120-222	67-154
Rhizoprionodon					
subgenus *Rhizoprionodon*	55-86	64-85	121-167	125-174	108-145
subgenus *Pretozygaena*	73-91	62-79	135-168	ca. 100-138	96-108
Loxodon	77-106	71-86	148-191	112-208	84-119
Scoliodon	97-112	50-62	148-171	ca. 100	
Prionace	142-149	>90-106	>237-252	110	38
Galeorhinus	83-106	53-54	136-160	114	82
Hemipristis	103-104	86-90	190-194	122-132	64-80
Galeocerdo	105-108	>114-126	>222-231	113-133	55-62
Negogaleus	74-81	63-69	137-150	139-148	108-141
Paragaleus	72-79	70	142-149	174-192	119-144
Sphyrnidae					
Sphyrna	52-107	64-108	116-206	ca. 100-178	63-133
SQUALOIDEA	44-90	13-36	60-126	118-233	65-200
Squalidae	54-90	22-36	78-126	118-233	65-180
Squalus	68-89	26-32	96-118	118-233	75-160
Centrophorus	82-90	24-32	106-122	122-136	78-100
Centroscymnus	74-79	26-34	102-109	122-137	65-128
Centroscyllium	61-67	26-30	88-97	141-200	106-130
Deania	85-90	34-36	119-126	133	80
Etmopterus	54-66	22-29	78-91	127-211	114-180
Oxynotidae					
Oxynotus	61-64	30	91-94	143	95
Dalatiidae	44-66	13-28	60-92	130-182	144-200
Dalatias	50-51	27-28	78-79	140-153	149-156
Scymnodalatias	58	23	81	130	152
Euprotomicrus	46-51	13-15	61-64	130-182	144-190
Heteroscymnoides	52	18	70	160	145
Isistius	60-66	20-27	81-92	150-172	147-200
Squaliolus	44-48	13	60-61	139-173	150-178
Somniosus	58	20	78		
Echinorhinidae					
Echinorhinus	uncalcified				
PRISTIOPHOROIDEA					
Pristiophoridae	100-109	40-55	149-157	114-150	75-100
Pristiophorus	100-109	40-55	149-157	114-150	75-100
Pliotrema	106	49	155	121	83
SQUATINOIDEA					
Squatinidae					
Squatina	92-108	28-34	121-141	133-135	53-70

*Includes data not in table 1.

TABLE 3.—Etmopterus spinax: *total vertebral numbers in females with litters (based on data in Punnett, 1904)*

Total vertebral count			Number of sibling embryos
Mother	Average of sibling embryos	Range of sibling embryos	
82	84.7	83-87	6
82	84.7	83-87	7
83	83.5	81-86	12
83	84.2	83-86	9
84	83.3	82-85	7
84	83.9	83-85	10
84	84.3	83-86	6
84	84.5	82-87	12
84	85.5	84-86	6
85	83.8	82-85	8
85	85.2	84-86	13
85	85.3	85-87	6
85	85.5	85-86	2
86	83.7	82-87	10
86	83.9	82-86	9
86	84.5	82-87	11
86	84.7	84-87	9
86	84.8	84-86	9
86	84.9	83-87	8
86	85.2	84-87	13
86	85.5	85-87	14
87	84.2	83-85	8
87	86.8	85-88	12
88	86.0	84-88	8
88	87.2	84-90	9

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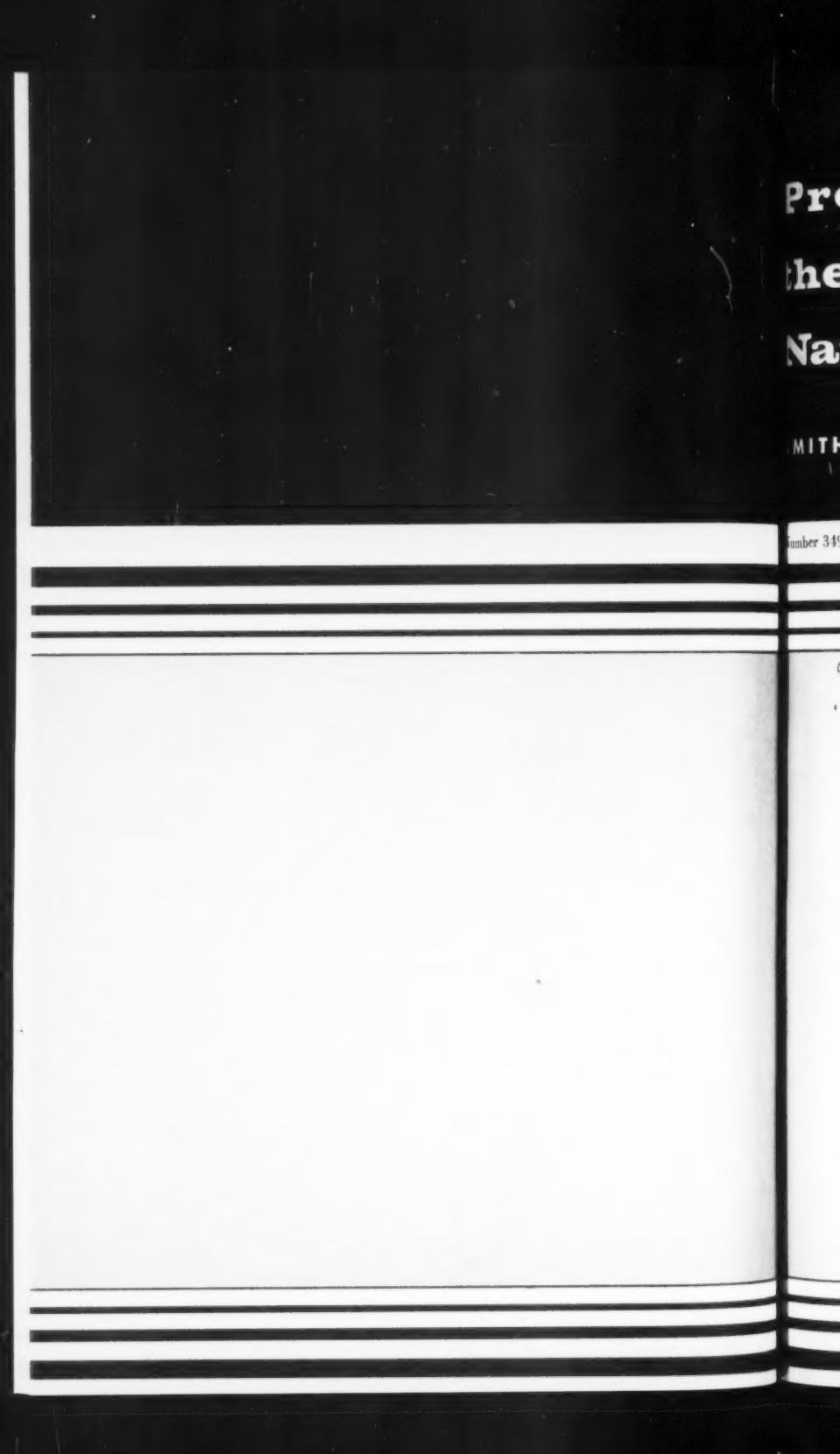
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NEOTROPICAL MICROLEPIDOPTERA, IV

A NEW GENUS OF STENOMIDAE WITH DESCRIPTIONS OF FOUR NEW SPECIES (LEPIDOPTERA: GELECHIOIDEA)

By W. DONALD DUCKWORTH

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NEOTROPICAL MICROLEPIDOPTERA, IV

A NEW GENUS OF STENOMIDAE WITH DESCRIPTIONS OF FOUR NEW SPECIES (LEPIDOPTERA: GELECHIOIDEA)

By W. Donald Duckworth

This, the fourth in a series of papers[1] dealing with Neotropical moths, is the first of a planned series on the family Stenomidae. The aim of this research program is a reclassification of the family Stenomidae that more adequately reflects the natural relationships of the species. The present plan is to continue to expand research already in progress on the genera and to conduct detailed studies of the species.

Since the genus *Stenoma* Zeller was proposed, it has become a "waste basket" for hundreds of species that could not be assigned readily to other genera on wing or palpal characters. Obviously this heterogeneity must be eliminated if the classification is to reflect natural relationships. In order to achieve this end, I find it necessary to regroup the species now assigned to the genus *Stenoma* according to their natural affinities.

The new genus described here is composed of ten species formerly

[1] Prepared with the aid of a National Science Foundation grant. Previous parts of this same series are: I and II, J. F. Gates Clarke, 1962, Proc. U.S. Nat. Mus., vol. 113, no. 3457, pp. 373–388; III, Clarke, 1964, ibid., vol. 115, no. 3480, pp. 61–84.

727-643—64

placed in *Stenoma*, of which one (*S. curiata*) is a synonym, together with four new species encountered during the course of this study. Unfortunately, as is the case for most species of Stenomidae, host plant records and other biological data are lacking; however, I hope that field explorations planned for the near future will correct this situation at least partially.

This research was aided by a grant from the National Science Foundation. The drawings were made by Mr. André Pizzini and the photographs by Mr. Jack Scott, staff photographer.

Genus *Lethata*, new genus

Type-species: *Stenoma trochalosticta* Walsingham, 1913, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 177.

Head with spreading lateral tufts. Labial palpus long, recurved; second segment thickened with appressed scales; apical segment acute, shorter than second. Forewing with costa arched, apex rounded, termen obliquely rounded, tornus rounded; 12 veins, all separate: 2 from before angle, 3 from angle, 4 approximate to 3, 7 to termen, 8 to apex. Hindwing broader than forewing; 8 veins: 3 and 4 connate, 6 and 7 connate. Abdomen of males with strong, eversible pair of hair-pencils contained in elongate cuplike pocket on first sternum (Fig. 3a).

Male genitalia: Uncus short, more or less recurved; tegumen somewhat narrowed in the area of the uncus and gnathos; gnathos fused, setiferous; harpe simple, bifurcate setae present or absent; anellar lobes symmetrical or asymmetrical; aedeagus with or without cornuti.

Female genitalia: Ostium bursae sclerotized; ductus bursae sclerotized to inception of ductus seminalis, membranous beyond; corpus bursae membranous, with two dentate signa connected by narrow, weakly sclerotized band.

This genus is distinguished readily from all other genera in the family Stenomidae by the setiferous gnathos and the two dentate signa connected by a weakly sclerotized band in the corpus bursae.

Although exact relationships are virtually impossible to ascertain at this time, the general structure of the genitalia in the genus *Lethata* indicates an affinity with *Gonioterma* Walsingham.

One of the most striking features of the family Stenomidae is the presence of modified setae on the harpes of the male genitalia. In the genus *Lethata*, however, apparently this character is not consistent. Initially it was thought that modified setae did not occur in the genus at all, but examination at very high magnifications revealed the tips of the setae to be bifurcate in some species. A seta of this type has

been illustrated in figure 2*j*. Other species were found lacking this condition, and since it is possible that the tips of the setae might be broken during the preparation of slides of the genitalia, definite conclusions concerning their presence or absence must await examination of additional material.

Key to the Species of *Lethata* Based on the Genitalia

1. Male 2
   Female 14
2. Anellar lobes symmetrical 3
   Anellar lobes asymmetrical 13
3. Vesica armed with cornuti 4
   Vesica without cornuti 12
4. Vesica armed with small spiculate cornuti 5
   Vesica armed with one or more large, heavily sclerotized cornuti . . . 7
5. Harpe with saccular lobe bearing two long, heavily sclerotized setae.
   L. trochilosticta (Walsingham)
   Harpe not as above. 6
6. Anellar lobes approximately triangular with single, short spine at apex; aedeagus without spine, apex blunt . . . . . **L. fusca,** new species
   Anellar lobes narrow with large, strongly recurved, hooklike spine at apex; aedeagus with posterior spine, apex sharply pointed.
   L. satyropa (Meyrick)
7. Aedeagus with apical process; anellar lobes narrowing sharply at middle forming narrow, apically acute projections 8
   Aedeagus without apical process; anellar lobes not narrowing sharply at middle 9
8. Aedeagus with apical process hooklike . . . . . **L. buscki,** new species
   Aedeagus with apical process straight . . . . . **L. asthenopa** (Meyrick)
9. Aedeagus with vesica armed with more than six cornuti 10
   Aedeagus with vesica armed with less than six cornuti 11
10. Aedeagus large, broad basally, vesica armed with ladder-like series of large to small cornuti extending from base to apex; anellar lobes of near uniform width throughout . . . . . **L. invigilans** (Meyrick)
    Aedeagus small, narrow, vesica armed with two clusters of small cornuti at apex and single, large cornutus basally; anellar lobes approximately triangular in shape, pointed at apex . . . . **L. maculata,** new species
11. Anellar lobes serrate beyond apical third; harpe broader basally.
    L. bovinella (Busck)
    Anellar lobes not serrate; harpe of approximately equal width throughout.
    L. leucothea (Busck)
12. Aedeagus with two laterally directed processes at apex, one extending from each side, the larger one slightly recurved . . . **L. glaucopa** (Meyrick)
    Aedeagus with large, heavily sclerotized process posteriorly.
    L. pyrenodes (Meyrick)
13. One anellar lobe long, narrow, curved 90° laterad at middle and extending to base of opposite harpe; the other shorter, broader, sharply recurved; aedeagus with large, recurved spine at apex . . **L. aromatica** (Meyrick)
    One anellar lobe narrow, pointed at apex; the other broad with three large spines apically; aedeagus with apex on one side produced into long blade-like process . . . . . **L. ruba,** new species

14. Inception of ductus seminalis near ostium bursae; ductus bursae with corrugated, pouchlike area just before ostium . **L. maculata**, new species
Inception of ductus seminalis near corpus bursae; ductus bursae not as above 15
15. Ductus bursae with corrugated, ribbon-like sclerotized area from ostium to inception of ductus seminalis . . . . . **L. invigilans** (Meyrick)
Ductus bursae with patch of small spines near inception of ductus seminalis. **L. bovinella** (Busck)

Lethata trochalosticta (Walsingham), new combination

FIGURES 1*b–d*, 4*a*

Stenoma trochalosticta Walsingham, 1913, *in* Godman and Salvin, Biologia Centrali-Americana, vol. 42 (Lepidoptera-Heterocera, vol. 4), p. 177.

Alar expanse 36 mm.

Antenna brownish. Head brownish gray shaded with rose; second segment of labial palpus rose on outer side, whitish on inner side, apical segment whitish. Legs whitish shaded with rose. Thorax deep ochreous with brownish-yellow tuft of white-tipped scales medially. Forewing deep ochreous with costa rosy red to apical third; from middle of base a reddish-brown shade blends outward and downward with ground color; spot at end of cell composed of ring of reddish brown enclosing spot of rosy red with fuscous spot in its center; cilia dark gray basally, lighter beyond. Hindwing whitish ochreous slightly overcast with gray scales; cilia rosy.

Male genitalia (slide WDD 2100, type): Uncus bluntly pointed apically, slightly recurved; gnathos short, apex flattened dorsally; harpe broad basally, sacculus produced into lobe that bears two long, heavily sclerotized setae, apex rounded; anellar lobes symmetrical, slightly recurved and bearing long setae apically; aedeagus with ventral lip of apex extending beyond dorsal lip and acute at apex, vesica armed with numerous spiculate cornuti.

Female genitalia: Unknown.

Type: In the United States National Museum.

Type locality: Chiriquí, Panama.

Distribution: PANAMA: Chiriquí. COSTA RICA: Sixaola River.

This species may be distinguished from other species of *Lethata* by the conspicuous ocellate spot at the end of the cell in the forewing and the saccular lobe bearing two long, heavily sclerotized setae on the harpe of the male genitalia.

Lethata aromatica (Meyrick), new combination

FIGURES 1*k,l*, 4*b*

Stenoma aromatica Meyrick, 1915, Exotic Microlepidoptera, vol. 1, p. 449.

Alar expanse 21–22 mm.

Antenna brown. Head brown; labial palpus whitish ochreous.

Legs white shaded with brown. Thorax and tegula brownish ochreous, with scattered fuscous scales; patches of brown scales at inner angle and along dorsum; faint transverse line from dorsum to middle at apical third; cilia brown basally, lighter beyond. Hindwing whitish, dorsal half shaded with dark scales; cilia whitish.

Male genitalia (slide WDD 3046): Uncus pointed apically, slightly recurved; gnathos long, finger-like; harpe broad basally, tapering to pointed apex; anellar lobes asymmetrical; one long, narrow, curved 90° laterad at middle and extended to base of opposite harpe; the other shorter, broader, sharply recurved; aedeagus with large recurved spine at apex, vesica without cornuti.

Female genitalia: Unknown.

Type: In the British Museum (Natural History).

Type locality: São Paulo, Brazil.

Distribution: BRAZIL: São Paulo; Paraná.

This species is known only from the male type in the British Museum (Natural History) and one male specimen from Paraná, Brazil, in the collection of the United States Natonal Museum.

The species is easily recognized by the striking development of the anellar lobes in the male genitalia.

***Lethata asthenopa* (Meyrick), new combination**

Stenoma asthenopa Meyrick, 1916, Exotic Microlepidoptera, vol. 1, p. 517.

This species is known only from the male type in the British Museum (Natural History), which has not been available for study; however, Clarke (1955, p. 212, pl. 106, figs. 2–2b) illustrates the wings and male genitalia. From these illustrations it is apparent that *S. asthenopa* belongs in the genus *Lethata* and is specifically distinct from the other species. Judging from the original description, *S. asthenopa* is closest to *L. fusca*, new species, in color and maculation. The color of the forewing of *L. asthenopa* is somewhat lighter brown than that of *L. fusca*. The genitalia afford a number of distinguishing characters, particularly the shape of the anellar lobes and the shape and armament of the aedeagus.

Type: In the British Museum (Natural History).

Type locality: Maroni River, French Guiana.

Distribution: FRENCH GUIANA: Maroni River.

***Lethata bovinella* (Busck), new combination**

FIGURES 1*i,j*, 3*d*, 4*c*

Stenoma bovinella Busck, 1914, Proc. U.S. Nat. Mus., vol. 47, p. 50.

Stenoma curiata Meyrick, 1929, Trans. Ent. Soc. London, vol. 76, p. 515. (New synonymy.)

Alar expanse 19–20 mm.

Antenna reddish brown basally, brown beyond. Head reddish brown, lighter between eyes; second segment of labial palpus whitish on inner side, brown on outer side, apical segment whitish. Legs whitish, shaded with brown. Thorax rosy ochreous dorsally, with central, posterior ridge of raised reddish brown scales. Forewings rosy ochreous with costa narrowly brick red; fuscous, nearly straight line extending from middle of costa to basal angle of dorsum; at apical fourth a transverse, outwardly curved fuscous line extending from costa to dorsum; at end of cell a circle of fuscous scales enclosing brown area slightly lighter than rest of wing; entire wing sprinkled with occasional fuscous scales; cilia rosy brown. Hindwing whitish ochreous with cilia slightly shaded with rose at apex.

Male genitalia (slide WDD 2095, type): Uncus bluntly pointed apically, slightly recurved; gnathos slightly flattened dorsoventrally; harpe bluntly pointed at apex; anellar lobes symmetrical, broad basally, tapering to slightly recurved, acute apex, and with medial edges serrate beyond apical third; aedeagus broad basally, narrower apically, vesica armed with several large, heavily sclerotized cornuti.

Female genitalia (slide WDD 3056): Ductus bursae with patch of small spines near inception of ductus seminalis; inception of ductus seminalis near corpus bursae.

Type: In the United States National Museum.

Type locality: Paraíso, Canal Zone, Panama (*S. bovinella*); Taboga Island, Panama, 200–1000 ft. (*S. curiata*).

Distribution: PANAMA: Paraíso, Canal Zone (June); Corozal, Canal Zone (June, July); Taboga Island, 200–1000 ft. (Sept.).

Meyrick described *S. curiata* from a series of females and Busck described *S. bovinella* from a series of males; however, examination of the types reveals both species identical in color and maculation and unquestionably the same species. The failure of past workers to accompany descriptions of new species with illustrations has resulted undoubtably in many synonyms of this type in the family Stenomidae.

The serrate anellar lobes in the male genitalia and the patch of small spines near the inception of the ductus seminalis in the female genitalia serve to distinguish *L. bovinella* from the other species of *Lethata*.

***Lethata buscki*, new species**

FIGURES 1*e,f*, 4*d*

Alar expanse 19–21 mm.

Antenna whitish basally, brown beyond. Head whitish shaded with rose; second segment of labial palpus brown on outer side,

whitish on inner side, apical segment whitish. Legs whitish, tarsi shaded with brown. Thorax brownish shaded with rose. Forewing deep ochreous with costa rose; spot at end of cell composed of ring of fuscous surrounding white scales; cilia rose basally, whitish beyond. Hindwings light ochreous slightly overcast with gray scales; cilia light ochreous tinted with rose.

Male genitalia (slide WDD 3048, type): Uncus bluntly pointed, slightly recurved; gnathos short; harpe of approximately uniform width from base to apical third, apex bluntly pointed; anellar lobes symmetrical, broad basally, narrowing sharply at middle forming narrow, apically acute projections; aedeagus short, apex with large hooked process, vesica armed with several heavy cornuti.

Female genitalia: Unknown.

Type: Punta Gorda, British Honduras. USNM 66685.

Distribution: BRITISH HONDURAS: Punta Gorda (July). HONDURAS: Río Temas.

Described from male holotype and one male paratype, July 1933 (G. H. and J. L. Sperry), Punta Gorda, British Honduras; and four male paratypes, Río Temas, Honduras.

The large hooked process on the apex of the aedeagus and the shape of the anellar lobes in the male genitalia readily distinguish this species from all others.

***Lethata fusca*, new species**

FIGURES 1*g,h*, 4*e*

Alar expanse 25 mm.

Antenna brownish. Head gray shaded with light purple, whitish between eyes; second segment of labial palpus fuscous on outer side, whitish on inner side, apical segment whitish. Legs whitish ochreous, forelegs and tarsi of mid- and hindlegs heavily shaded with fuscous. Thorax fuscous slightly shaded with purple, with median posterior tuft of white-tipped fuscous scales. Forewing fuscous with slight purplish hue; costa narrowly light rosy ochreous; dark fuscous dot in fold at basal third; spot at end of cell white edged with dark fuscous; outwardly curved, transverse row of dark fuscous dots at apical four-fifths; cilia fuscous. Hindwing whitish ochreous shaded with gray; cilia whitish ochreous.

Male genitalia (slide WDD 3054, type): Uncus bluntly pointed, slightly recurved; gnathos short; harpe narrow, apex pointed; anellar lobes symmetrical, roughly triangular in shape with a large spine at apex; aedeagus long, narrow, vesica without cornuti.

Female genitalia: Unknown.

Type: Santarém, Brazil. USNM 66686.

Distribution: BRAZIL: Santarém.

Described from male holotype, 7.27. (Z.), Santarém, Brazil.

The specimen from which this species is described bears labels indicating it had been compared with the type of *Stenoma asthenopa*, with which it agrees in color and maculation but in a darker shade. Examination of the genitalia indicates that the specimen is not *L. asthenopa* but rather a new species. The apical spine on the anellar lobes and the absence of cornuti in the aedeagus of the male genitalia readily separates *L. fusca* from *L. asthenopa* and the other species of *Lethata*.

Lethata glaucopa (Meyrick), new combination

FIGURES 1*a*, 2*a*, 4*f*

Stenoma glaucopa Meyrick, 1912, Trans. Ent. Soc. London, vol. 1911, p. 712.

Alar expanse 32–38 mm.

Antenna whitish basally, darker beyond. Head rosy fulvous, lighter between eyes; second segment of labial palpus brown, apical segment whitish. Legs whitish shaded with brown. Thorax brown shaded with rose. Forewing brownish shaded with yellow with costa narrowly rosy to brick red; spot at end of cell whitish with dark gray center; cilia brown. Hindwing whitish, shaded with brown to dark brown; cilia brown.

Male genitalia (slide WDD 2684): Uncus pointed, recurved; gnathos short, broad at tip; harpe bluntly pointed at apex; anellar lobes symmetrical, short, broad, nearly truncate at apex; aedeagus large with slight lateral bend, apex with two laterally directed processes at apex, one extending from each side, the larger one slightly recurved, vesica without cornuti.

Female genitalia: Illustrated in Clarke (1955, p. 313, figs. 4–4c). The illustration is not clear enough to provide a detailed description of the female genitalia.

Type: In the British Museum (Natural History).

Type locality: San Antonio, Colombia, 5800 ft.

Distribution: COLOMBIA: San Antonio, 5800 ft. (Nov.).

This is the largest species in the genus *Lethata*. It is known only from the type, a female in the British Museum, and a male specimen in the U.S. National Museum, both from the same locality. The two laterally directed apical processes on the aedeagus in the male genitalia readily separates *L. glaucopa* from the other species.

***Lethata invigilans* (Meyrick), new combination**

FIGURES 2*b*,*c*, 3*b*, 5*a*

Stenoma invigilans Meyrick, 1915, Exotic Microlepidoptera, vol. 1, p. 476.

Alar expanse 24–26 mm.

Antenna brownish. Head whitish; second segment of labial palpus brown on outer side, whitish on inner side; apical segment whitish. Legs whitish, heavily shaded with brown on outer surfaces. Thorax light brown. Forewing light brown with scattered fuscous scales; costa dull rose; three indistinct fuscous transverse lines, one at basal third, one at middle, and one at apical third; large, conspicuous fuscous spot at end of cell; marginal series of fuscous dots around apex and termen; cilia whitish gray slightly shaded with rose. Hindwing gray; cilia pale grayish.

Male genitalia (slide WDD 2803): Uncus pointed, recurved; gnathos very long, finger-like; harpe narrow, slightly recurved, pointed at apex; anellar lobes symmetrical, of near uniform width throughout, platelike, only slightly recurved, aedeagus large, broad basally, anterior lip of apex somewhat produced, vesica armed with ladder-like series of large to small cornuti extending from base to apex.

Female genitalia (slide WDD 2809): Ductus bursae with corrugated, ribbon-like sclerotized area from ostium to inception of ductus seminalis; inception of ductus seminalis near corpus bursae.

Type: In the British Museum (Natural History).

Type locality: Maroni River, French Guiana.

Distribution: FRENCH GUIANA: Maroni River, Cayenne. SURINAM: Cottica River, Moengo (May). VENEZUELA: Sanariapo, Amazonas (Aug.).

For many years this species has been known only from the two male specimens on which Meyrick based the original description. During the course of the present study, four additional specimens, three males and one female, were discovered among the unidentified material in the U.S. National Museum collection. These specimens not only broadened our knowledge of the distribution of the species but also allowed description of the female, which was not previously known.

The large, conspicuous, fuscous spot at the end of the cell on the forewing provides the most distinct superficial character for recognition of this species; however, one specimen studied had this spot considerably reduced, suggesting that it is more variable than previously thought and should be used with reservations. The ladder-like arrangement of the cornuti in the aedeagus of the male genitalia and the sclerotized ribbon-like area extending from the ostium to the

inception of the ductus seminalis in the female genitalia readily identifies this species.

Lethata leucothea (Busck), new combination

FIGURES 2*d*, 5*b*

Stenoma leucothea Busck, 1914, Proc. U.S. Nat. Mus., vol. 47, p. 50.

Alar expanse 20 mm.

Antenna light brown. Head rosy ochreous; second segment of labial palpus brown on outer side, pale rosy ochreous on inner side; apical segment pale rosy ochreous. Legs whitish, forelegs heavily shaded with brown, mid- and hindlegs slightly shaded with brown. Thorax rosy ochreous, with posteromedian ridge of raised reddish-brown scales. Forewing pale ochreous gray with costa narrowly brick red; dorsal edge narrowly deep ochreous; spot at end of cell consisting of light yellow spot ringed with fuscous scales; outwardly curved transverse fuscous line at apical third; less distinct transverse fuscous line at middle; an even less distinct transverse line at basal third; cilia rosy ochreous. Hindwing light ochreous shaded with gray scales; cilia grayish ochreous.

Male genitalia (slide AB, type): Uncus recurved at tip; gnathos short, broad; harpe short, of approximately equal width throughout, broadly rounded at apex; anellar lobes symmetrical, bluntly pointed at apex; aedeagus large, robust, vesica armed with three large, heavily sclerotized cornuti.

Female genitalia: Unknown.

Type: In the United States National Museum.

Type locality: Trinidad River, Panama.

Distribution: PANAMA: Trinidad River (March).

This species is known only from the type specimen. It is closest to *L. bovinella;* however, the shape of the harpes and anellar lobes, together with the number of cornuti in the aedeagus of the male genitalia, serve to separate the two species.

Lethata maculata, new species

FIGURES 2*e*,*f*, 3*c*, 5*c*

Alar expanse 24–31 mm.

Antenna brownish. Head whitish ochreous shaded with rose; second segment of labial palpus brown on outer side, whitish on inner side, apical segment white on outer side, brown on inner side. Legs whitish shaded with brown. Thorax deep yellow ochreous slightly shaded with rose, with tuft of white-tipped gray scales posteriorly. Forewing deep yellow ochreous with costa narrowly red ochreous;

area of faint rose runs parallel to, and just below, costa; dorsum narrowly reddish brown; indistinct fuscous spot on costa at middle, from which indistinct, oblique fuscous line runs to anal angle; indistinct, outwardly curved, transverse fuscous line at apical four-fifths; spot at end of cell a rather indistinct area of white surrounded by fuscous scales; apical margin rich yellow; entire wing sprinkled with fuscous scales; cilia rosy ochreous. Hindwing ochreous, anal area shaded with gray; cilia rosy ochreous.

Male genitalia (slide WDD 3061, type): Uncus bluntly pointed, slightly recurved; gnathos long, finger-like; harpe short, broadest near middle, bluntly pointed at apex; anellar lobes elongate triangular-shaped, pointed at apex; aedeagus small, narrow, vesica armed with two clusters of small cornuti at apex and single, large cornutus basally.

Female genitalia (slide WDD 2799, paratype): Ductus bursae with corrugated, pouchlike area just before ostium bursae; inception of ductus seminalis near ostium.

Type: Nova Teutônia, Brazil, 3500 m. USNM 66687.

Distribution: BRAZIL: Nova Teutônia (Oct.). SURINAM: Cottica River, Moengo (May).

Described from male holotype, Oct. 21, 1948 (Fritz Plaumann), Nova Teutônia, Brazil, 3500 m.; one male paratype, 1.20 (Parish), Tefe, Brazil; and one female paratype, Oct. 21, 1948 (Fritz Plaumann), Nova Teutônia, Brazil, 3500 m.

This species is distinguished readily by the two apical clusters of small cornuti and a single, large basal cornutus in the aedeagus of the male genitalia and by the ductus bursae of the female genitalia with a corrugated, pouchlike area near the ostium bursae.

***Lethata pyrenodes* (Meyrick), new combination**

FIGURES 2*g*, 5*d*

Stenoma pyrenodes Meyrick, 1915, Exotic Microlepidoptera, vol. 1, p. 448.

Alar expanse 19 mm.

Antenna brownish. Head, palpus, and thorax deep ochreous shaded with rose. Forewing yellow ochreous, fuscous triangular spot at middle of costa; spot at end of cell small, fuscous; faint fuscous line from costal spot to dorsum; outwardly curved, transverse fuscous line from apical third of costa to near tornus; cilia whitish ochreous shaded with rose. Hindwings whitish ochreous, apex and termen faintly yellowish; cilia whitish ochreous.

Male genitalia (slide WDD 2817): Uncus pointed, sharply recurved; gnathos short, broad; harpe short, broad, rounded at apex; anellar

lobes symmetrical, approximately same width throughout; aedeagus large, with large, heavily sclerotized process posteriorly, vesica without cornuti.

Female genitalia: Illustrated in Clarke (1955, p. 350, figs. 4–4c). The illustration is not clear enough to provide a detailed description of the female genitalia.

Type: In the British Museum (Natural History).

Type locality: Paraná, Argentina.

Distribution: ARGENTINA: Paraná. BRAZIL: Castro, Paraná.

This species is known only from the female type in the British Museum and one male specimen in the U.S. National Museum. The short broad harpe and large, heavily sclerotized, posterior process in the aedeagus of the male genitalia readily separates *L. pyrenodes* from all other species.

Lethata ruba, new species

FIGURES 3*a*, 5*e*

Alar expanse 30 mm.

Antenna whitish basally, brown beyond. Head whitish shaded with rose, face lighter; second segment of labial palpus brown on outer side, lighter on inner side, apical segment brown. Legs whitish shaded with brown. Thorax deep yellow ochreous lightly shaded with rose, with slight tuft of gray scales posteriorly. Forewing deep yellow ochreous with costa narrowly brick red; broad band of pink extends parallel to costa from base to apex blending into groundcolor at apical third; spot at end of cell fuscous; few fuscous scales scattered over entire wing; cilia whitish tinted with rose. Hindwing whitish ochreous lightly shaded with gray; cilia whitish.

Male genitalia (slide WDD 2800, type): Uncus very short, broad, sharply recurved; gnathos short, V-shaped at tip; harpe short, rounded at apex; anellar lobes asymmetrical; one narrow, pointed at apex; one broad, with three large spines apically. Aedeagus with apex on one side produced into long bladelike process, vesica without cornuti.

Female genitalia: Unknown.

Type: Nova Teutônia, Brazil, 3500 m. USNM 66688.

Distribution: BRAZIL: Nova Teutônia, 3500 m. (Aug.).

Described from male holotype, Aug. 6, 1948 (Fritz Plaumann), Nova Teutônia, Brazil, 3500 m.

The shape of the asymmetrical anellar lobes and the bladelike process on the apex of the aedeagus distinguish this species from all others in the genus *Lethata*.

***Lethata satyropa* (Meyrick), new combination**

FIGURES 2*h-j*, 5*f*

Stenoma satyropa Meyrick, 1915, Exotic Microlepidoptera, vol. 1, p. 478.

Alar expanse 24–25 mm.

Antenna brownish. Head rosy whitish, crown suffused with deep ochre; second segment of palpus brown on outer side, white on inner side, apical segment whitish. Legs whitish shaded with brown. Thorax deep ochreous, becoming darker posteriorly. Forewing deep ochreous with costa dull red from base to apical third; dorsum narrowly brown red throughout; an indistinct dark line at basal third from dorsum to middle, a large, round fuscous spot at end of cell containing transverse purplish spot; faint, curved, transverse line from costa to dorsum at apical four-fifths; entire wing sprinkled with fuscous scales; cilia ochreous, suffused with purplish on outer half. Hindwings whitish ochreous slightly overcast with gray scales, apical and terminal edge yellow; cilia white, tinted with rose.

Male genitalia (slide WDD 2651): Uncus pointed apically, slightly recurved; gnathos short, blunt at apex; harpe broadest at midpoint, bluntly pointed at apex; anellar lobes symmetrical, apex of each developed into strongly recurved, hooklike spine; aedeagus tapering from middle to extremely sharp-pointed apex, single long spine projects posteriorly from near middle, vesica armed with numerous spiculate cornuti.

Female genitalia: Unknown.

Type: In the British Museum (Natural History).

Type locality: Godebert, Maroni River, French Guiana.

Distribution: FRENCH GUIANA: Godebert, Maroni River.

This species is known only from the male type in the British Museum and a male specimen in the U.S. National Museum, both from the same locality. The shape of the aedeagus and the large posterior process from its middle, plus the shape of the anellar lobes, provide ample distinguishing characters in the male genitalia.

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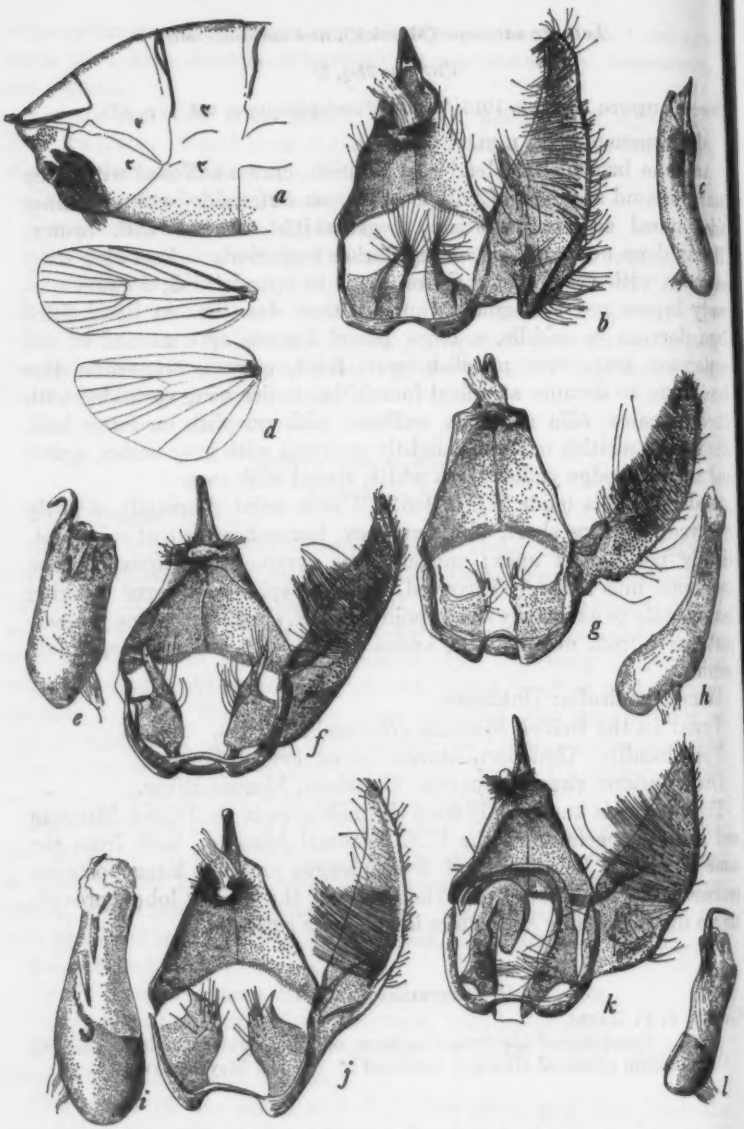

FIGURE 1.—Lateral view of abdominal segments 1–3: a, *Lethata glaucopa* (Meyrick). Ventral view of male genitalia, aedeagus removed: b, *L. trochalosticta* (Walsingham); f, *L. buscki*, new species; g, *L. fusca*, new species; j, *L. bovinella* (Busck); k, *L. aromatica* (Meyrick). Aedeagus: c, *L. trochalosticta* (Walsingham); e, *L. buscki*, new species; h, *L. fusca*, new species; i, *L. bovinella* (Busck); l, *L. aromatica* (Meyrick). Wing venation: d, *L. trochalosticta* (Walsingham).

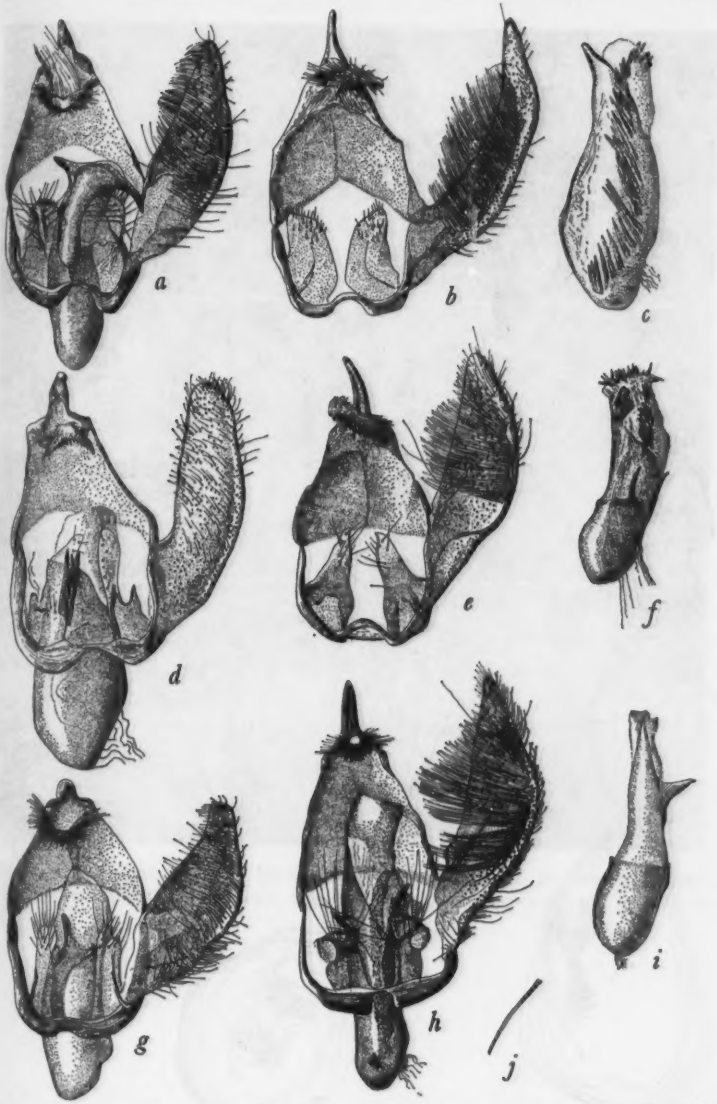

FIGURE 2.—Ventral view of male genitalia. Aedeagus in situ: a, *Lethata glaucopa* (Meyrick); d, *L. leucothea* (Busck); g, *L. pyrenodes* (Meyrick); h, *L. satyropa* (Meyrick). Aedeagus removed: b, *L. invigilans* (Meyrick); e, *L. maculata*, new species. Aedeagus: c, *L. invigilans* (Meyrick); f, *L. maculata*, new species. Lateral view of aedeagus: i, *L. satyropa* (Meyrick). Enlarged view of bifurcate seta: j, *L. satyropa* (Meyrick).

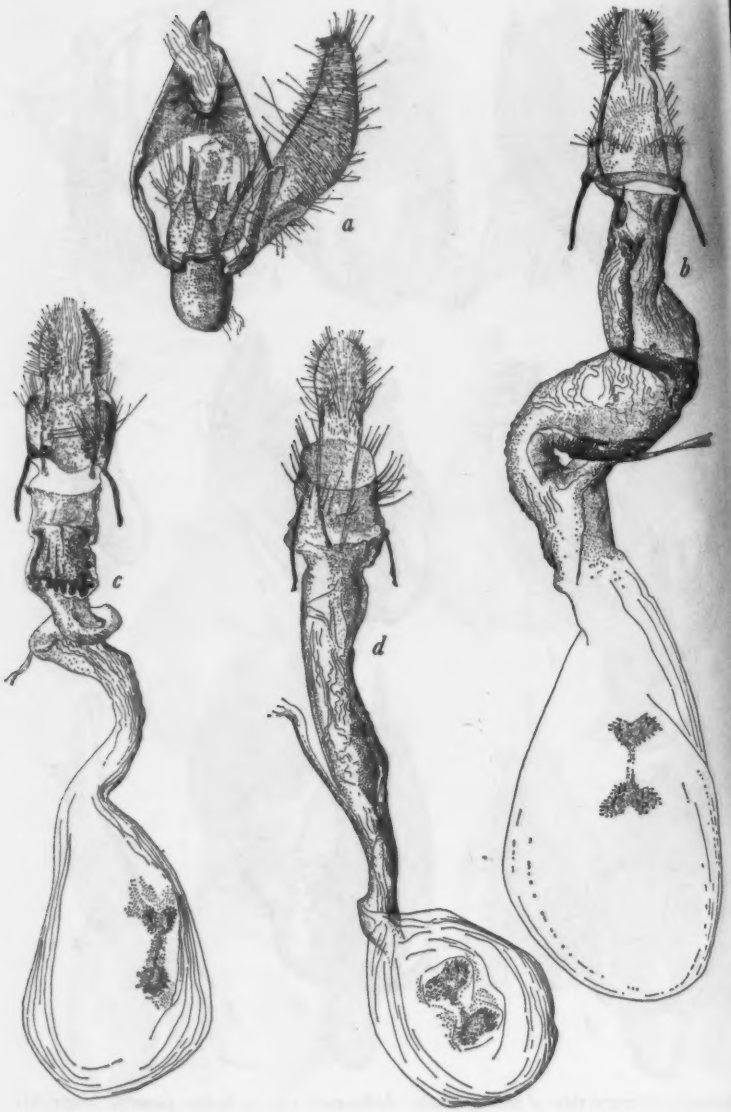

FIGURE 3.—Ventral view of male and female genitalia: a, *Lethata ruba*, new species, aedeagus in situ; b, *L. invigilans* (Meyrick); c, *L. maculata*, new species; d, *L. bovinella* (Busck).

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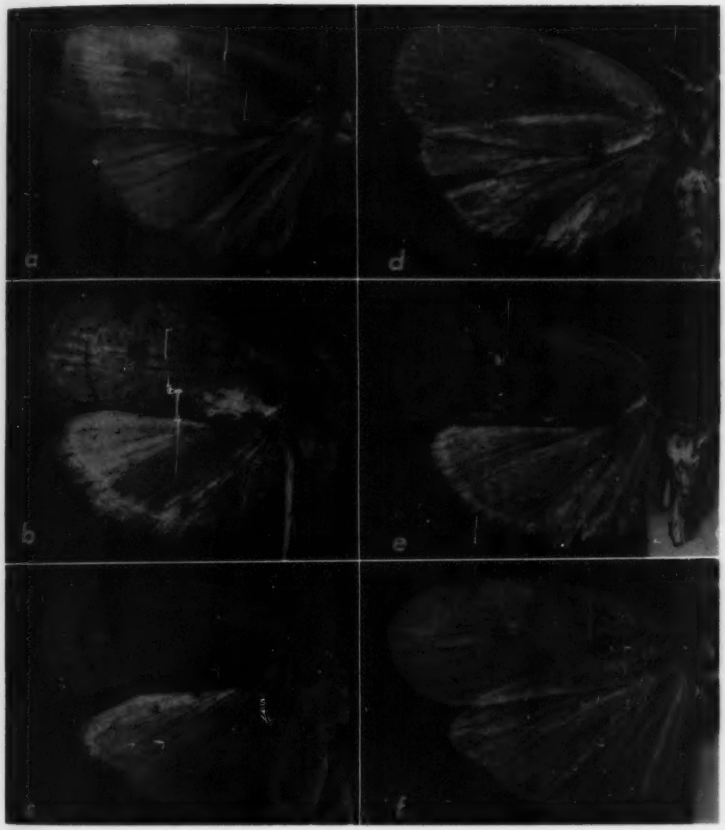


FIGURE 4.—Left wing: a, *Lethata trochalosticta* (Walsingham); b, *L. aromatica* (Meyrick); c, *L. bovinella* (Busck); d, *L. buscki*, new species; e, *L. fusca*, new species; f, *L. glaucopa* (Meyrick).

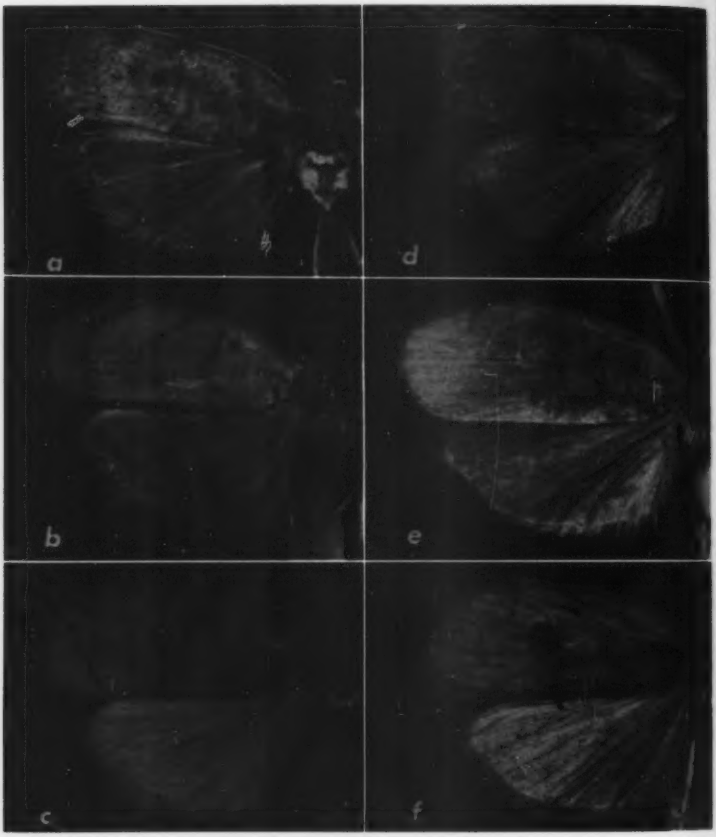
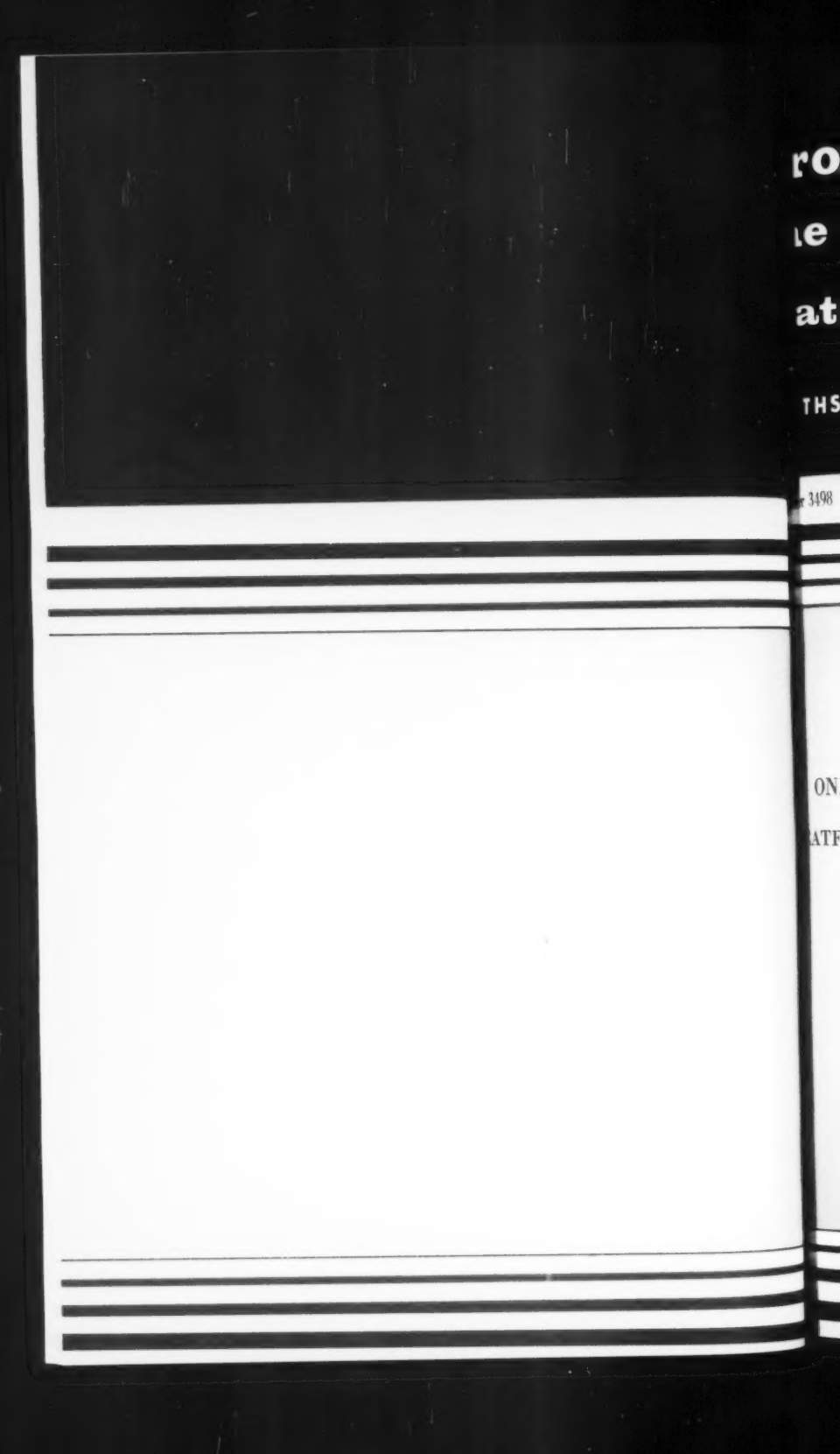


FIGURE 5.—Left wing: a, *Lethata invigilans* (Meyrick); b, *L. leucothea* (Busck); c, *L. maculata*, new species; d, *L. pyrenodes* (Meyrick); e, *L. ruba*, new species; f, *L. satyropa* (Meyrick).



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ONE NEW SPECIES AND TWO REDESCRIPTIONS OF ATFISHES OF THE SOUTH AMERICAN CALLICHTHYID GENUS CORYDORAS

By STANLEY H. WEITZMAN

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Volume 116 1964 Number 3498

ONE NEW SPECIES AND TWO REDESCRIPTIONS OF CATFISHES OF THE SOUTH AMERICAN CALLICHTHYID GENUS CORYDORAS

By Stanley H. Weitzman

Recent examination of three specimens of a new catfish from Brazil, herein described as *Corydoras semiaquilus*, has instigated reexamination and redescription of its apparent relatives, *C. treitlii* Steindachner (1906) and *C. fowleri* Böhlke (1950). *C. fowleri* is known only from the holotype, which was described without illustration. In addition, the original description of *C. fowleri*, like that of *C. cochui* Myers and Weitzman (1954) (see Weitzman, 1956), was published in an aquarium magazine not available in many university libraries, *C. treitlii* has never been illustrated and its original description, although excellent for its time, is now inadequate in the light of many subsequent new species. Discovery of apparent close relatives of *C. treitlii* has made reexamination and description of the type specimens imperative.

I am indebted to Professor George S. Myers for the loan of specimens and the use of facilities in the Division of Systematic Biology at Stanford University; to Dr. Paul Kähsbauer of the Naturhistorisches Museum, Wien, for the loan of type specimens of *Corydoras* described by Franz Steindachner; to Mr. W. I. Follett, Curator of Fishes of the California Academy of Sciences, for the loan of specimens; to Mr.

Harald Schultz, São Paulo, Brazil, for locality data and for collecting the specimens of *C. semiaquilus;* and to Dr. Herbert Axelrod of Jersey City, New Jersey, for two specimens of *C. semiaquilus.* I also wish to thank Dr. W. Klausewitz and Mr. Fritz Rössel of the Senckenbergische Naturforschende Gesellschaft, Natur-Museum und Forschungs-institut, for the loan of a specimen of *C. semiaquilus.*

The following abbreviations are used:

NMW—Naturhistorisches Museum, Wien
USNM—United States National Museum
SU—Division of Systematic Biology, Department of Biological Sciences, Stanford University
SM—Senckenberg Museum.

Corydoras treitlii Steindachner

FIGURES 1 and 2

Corydoras treitlii Steindachner, 1906, p. 478 (original description; type locality: mouth of a small stream emptying into the Rio Parnahyba at Victoria, State of Maranhão, Brazil).—Eigenmann, 1910, p. 403 (listed).—Miranda Ribeiro, 1911, p. 167 (description copied from Steindachner, 1906).—Regan, 1912, p. 210 (description copied from Steindachner, 1906).—Ellis, 1913, p. 407 (listed).—Gosline, 1940, p. 15 (aquarium specimen, no description); 1945, p. 74 (listed).—Stigchel, 1946, p. 129 (description of specimen from original collection).—Böhlke, 1950, p. 27 (discussion of relationships with *Corydoras fowleri*).—Fowler, 1954, p. 67 (listed).

LECTOTYPE.—NMW 61103, standard length 42.6 mm., collected during 1903 by Franz Steindachner at mouth of brook emptying into Rio Paranhyba [Parnaíba River] at Victoria [Alto Parnaíba], State of Maranhão, Brazil.

ADDITIONAL SPECIMENS.—NMW 47798, paralectotype, standard length 42.4 mm., same data as lectotype; USNM 176912, standard length 52.5 mm., São Paulo, Brazil, Herbert Axelrod, 1958; SU 35054, standard length 47.0 mm., sent to the Division of Systematic Biology, Stanford University, by Mr. Fred H. Stoye in March 1937. Mr. Stoye stated that, according to Mr. N. Greim, this is an aquarium specimen from the Amazon. In my opinion this locality data is uncertain. This is the specimen utilized by Gosline (1940).

DIAGNOSIS.—*Corydoras treitlii* may be distinguished from other species of *Corydoras* by the following combination of characters: Snout long, about 30 to 32% of body length without head. Least caudal peduncle depth about 57 to 62% of snout length. Imbricated thoracic and abdominal plates absent; fine bony prickles present in these regions. Dorsal fin spine about equal in length to pectoral fin spine. Predorsal length about 79 to 89% of distance between dorsal fin origin and caudal fin base. Caudal fin without bars.

DESCRIPTION.—(For actual measurements see table 1.) In the description below, the proportions are given first, percentages follow in parentheses, both of which derive from standard length unless otherwise designated. Data for the lectotype, NMW 61103, is given first, data for NMW 47798 follows in brackets. Data for USNM 179612 and for SU 35054 are designated by respective abbreviations.

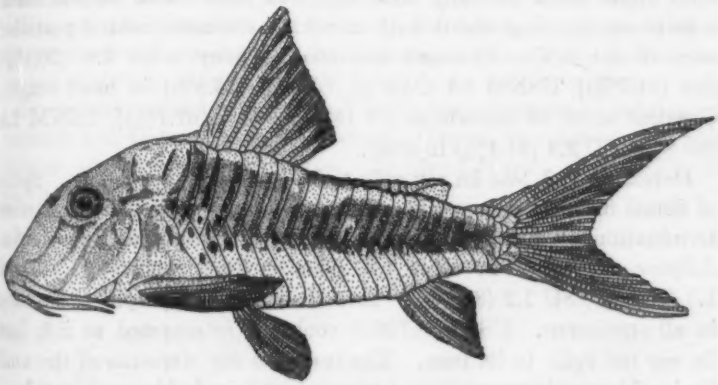

FIGURE 1.—*Corydoras treitlii* Steindachner, lectotype, NMW 61103. Standard length 42.6 mm.

Body fairly elongate, compressed posteriorly. Greatest body depth 2.9 (34.8%) [2.8 (35.6%)], USNM 2.8 (35.8%), SU 2.9 (34.4%). Least depth of caudal peduncle 7.5 (13.4%) [7.2 (13.9%)], USNM 7.7 (15.0%), SU 7.6 (13.1%). Distance between snout tip and dorsal fin origin 1.8 (56.4%) [2.0 (49.1%)], USNM 2.0 (51.0%), SU 1.9 (52.3%). Distance between snout tip and anus 1.9 (52.8%) [1.8 (55.0%)], USNM 1.9 (52.0%), SU 2.0 (49.8%). Anal fin origin to snout tip 1.3 (80.0%) [1.2 (80.8%)], USNM 1.3 (79.8%), SU 1.2 (80.6%). Lateral scutes 24/21 in all four specimens. Abdomen and thorax with small prickles in all specimens, no heavy imbricated plates. In SU 35054, a poorly preserved specimen, many of these prickles have been broken off in exposed areas but their bases remain. Azygous middorsal scutes 6 [4], USNM 4, SU 5, before adipose fin. One azygous scute before dorsal fin in all specimens. Pectoral fin base incompletely surrounded by coracoid in all specimens. Distance between coracoids variable (probably wider in females than in males) 10.9 (9.2%) [9.2 (10.9%)], USNM 11.3 (8.8%), SU 13.4 (7.5%). Head length 3.0 (33.3%) [2.9 (33.8%)], USNM 3.0 (33.3%), SU (34.2%). Greatest head width 1.4 (71.8%) [1.5 (68.7%)], USNM 1.5 (67.4%), SU 1.7 (59.5%) in head length. Least width of bony inter-

orbital 3.2 (31.0%) [4.0 (25.2%)], USNM 3.1 (32.0%), SU 3.5 (28.4%) in head length. Snout acute in dorsal view. Snout tip rounded in lectotype, much more acute in SU 35054 (a poorly preserved, dehydrated specimen). Snout 1.4 (70.4%) [1.5 (66.4%)], USNM 1.6 (64.0%), SU 1.5 (64.9%) in head length. Dorsal profile of snout slightly concave in all specimens. When directed posteriorly, both upper rictal (actually maxillary) and lower rictal barbels reach a point on a vertical about half an orbital diameter behind posterior edge of the orbit. Greatest diameter of bony orbit 3.8 (26.1%) [4.6 (21.7%)], USNM 4.1 (24.6%), SU 3.9 (25.8%) in head length. Greatest width of suborbital 2.3 (43.3%) [1.5 (67.7%)], USNM 1.4 (69.8%), SU 2.4 (41.1%) in orbit.

Dorsal fin I, 7, last fin ray split to its base in all specimens. Spine of dorsal fin when depressed reaching to, or slightly beyond, posterior termination of dorsal fin base, distant from origin of adipose fin. Adipose fin spine in orbit 1.0 (97.4%) [1.0 (100.3%)], USNM 1.3 (79.0%), SU 1.2 (84.7%). Anal fin ii,5, last ray split to its base in all specimens. USNM 179612 could be interpreted as ii,6, last fin ray not split to its base. The last two ray elements of the anal fin in this specimen are well separated and probably each ray base belongs to its own separate pterygiophore series. Pectoral fin I,10, [I,11], USNM I,10, and SU I,10. Pelvic rays i,5, in all specimens. Principal caudal rays 7/7 in all specimens. Pectoral fin spine (see fig. 2) with 16 [18], USNM 21, SU 16, stout spinules along its posterior border.

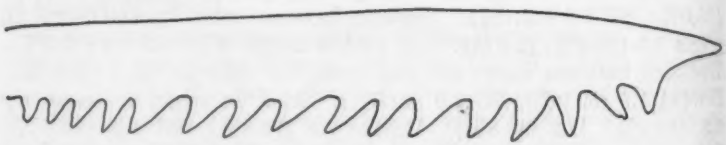

FIGURE 2.—*Corydoras treitlii* Steindachner. Pectoral fin spine of lectotype, ventral view, left spine.

COLOR.—The lectotype has the following color pattern in alcohol (see also fig. 1.): Basic body color yellowish gray. Head with brown markings as shown in figure 1; no punctate or vermiculate markings over snout or head. Sides with purplish dark brown markings on upper body scutes. All specimens with all fins hyaline, completely lacking bars, bands, or blotches. All specimens with color pattern very similar to lectotype except that SU 35054 greatly faded. Color in life not known.

Corydoras fowleri Böhlke

FIGURES 3 and 4

Corydoras fowleri Böhlke, 1950, p. 26 (original description; type locality: Caño del Chancho, near Pevas, Peru).

HOLOTYPE: SU 16115, a female 66.0 mm. in standard length, collected December 13, 1941, by Mr. William G. Scherer at Caño del Chancho, near Pevas [Pebas], Peru.

DIAGNOSIS.—*Corydoras fowleri* may be distinguished from other known species of *Corydoras* by the following combination of characters: Snout relatively long, about 25% of body length without head. Least caudal peduncle depth about 55% of snout length. Imbricated thoracic and abdominal plates present. Dorsal fin spine weaker and shorter than pectoral fin spine. Predorsal length about 67% of postdorsal length.

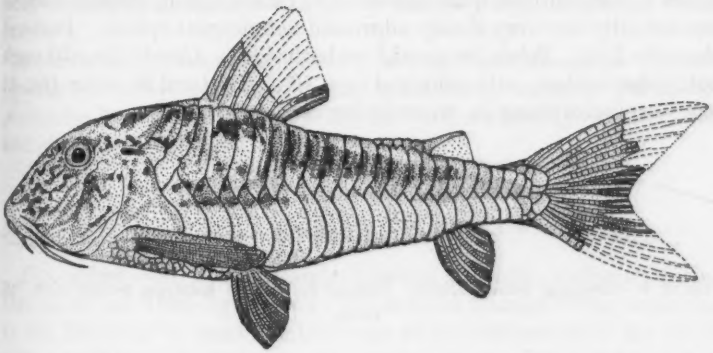

FIGURE 3.—*Corydoras fowleri* Böhlke, holotype, SU 16115. Standard length 66.0 mm.

DESCRIPTION.—(See table 1 for measurements.) For explanation of descriptive pattern below, see p. 117.

Body elongate, especially slender posterior to dorsal and pelvic fins; greatest body depth 3.3 (30.8%). Least depth of caudal peduncle 10.0 (10.0%). Dorsal fin origin much nearer to snout tip than caudal fin base. Distance between snout tip and dorsal fin origin 2.3 (43.4%). Distance between snout tip and anus 2.0 (49.5%). Anal fin origin to snout tip 1.2 (80.0%). Lateral scutes 24/21. Abdomen and thorax entirely covered with small- to moderate-sized imbricated plates. Azygous middorsal scutes 5 anterior to adipose fin, 1 anterior to dorsal fin. Pectoral fin base incompletely surrounded by coracoid, interval or hiatus filled with moderate-sized plates continuous with those of abdomen and thorax. Distance between coracoids 7.8 (12.9%). Head length 3.8 (26.6%); greatest

head width 1.3 (75.5%) in its length. Least width of bony interorbital 3.1 (32.0%) in head length. Snout acute in dorsal view but snout tip rather rounded. Snout length 1.4 (69.2%) in head length. Dorsal profile of snout slightly concave. When directed posteriorly, both rictal barbels of both sides reach a point on a vertical line from posterior eye margin. Greatest diameter of orbit 4.4 (22.8%) in head length. Greatest width of suborbital 2.9 (35.0%) in orbit.

Dorsal fin I,7, last fin ray split to its base. Dorsal fin damaged, its spine and anteriormost rays partially lost as shown in figure 3. Dorsal fin spine rather slender, considerably more slender than the pectoral fin spines. Adipose fin spine 0.95 (104.8%) in orbit. Anal fin ii,5, last ray split to its base. Böhlke (1950) reported the anal fin count as "I,5, the last ray widely split to its base." I found that in taking counts and measurements I had counted this fin as i,5; however, during careful examination of the fin while preparing figure 3, I found that what appeared to be a single nonpungent spine was actually two very closely adpressed nonpungent spines. Pectoral elements I,10. Pelvic fin rays i,5 on both sides. Caudal fin, although both lobes broken, with principal rays 7/7. Pectoral fin spine (fig. 4) has 30 spinules along its posterior border.

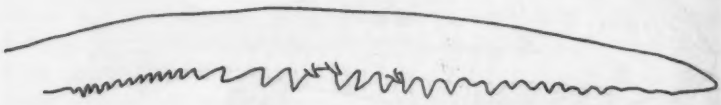

FIGURE 4.—*Corydoras fowleri* Böhlke. Pectoral fin spine of holotype, ventral view, left spine.

COLOR.—Specimen appears somewhat faded. Overall body color very pale brown. Ventral region below gills white. Just posterior to this region, at origin of belly scutes, belly region becomes very pale brown. Pattern of dark brown markings shown in figure 3. This pattern described by Böhlke (1950) as follows:

> . . . dark blotch along base of dorsal fin, abruptly shifted ventrally at a vertical with the fifth articulated dorsal ray. This posterior continuation of the blotch covers the lower two-thirds of the upper row of lateral scutes, and continues back to below the adipose dorsal. Several small dark spots at the upper end of the gill openings, somewhat resembling a broken-up humeral spot. Top of head, snout, and cheeks covered by wavy longitudinal dark lines.

Little can be added to this description.

DISCUSSION.—As noted by Böhlke (1950), *Corydoras fowleri* appears to be related to *C. treitlii*; however, as he remarked, it differs from *C. treitlii* in possessing imbricated thoracic and abdominal plates and a longer body in relation to head length. In addition to these charac-

ters, it has a much weaker (and probably shorter) dorsal fin spine than pectoral spine. The pectoral and dorsal fin spines of *C. treitlii* are about equal in diameter and length. *Corydoras fowleri* appears closely related to *C. semiaquilus* but differs in the characteristics noted under the latter species.

The swollen appearance of the holotype of *Corydoras fowleri* indicates that the specimen is probably a gravid female. This probability was verified by probing between the lower third and fourth lateral scutes of the right side in the upper regions of the coelomic cavity, where a few mature eggs were recovered. Since the holotype and only known specimen of *C. fowleri* is a female, apparently swollen with ripe eggs, and since males of the genus *Corydoras* are usually slenderer than their female counterparts, it is quite likely that the species *C. fowleri* has an average body depth much less than that indicated here. Thus, *C. fowleri* probably differs more from *C. semiaquilus* and *C. treitlii* with regard to body depth than the data avilable at present would indicate.

In summary, *Corydoras fowleri* is related most closely to *C. semiaquilus* but differs from that species in its shorter snout, longer caudal peduncle length, lesser body depth, proportionately smaller eye, and shorter head length.

Corydoras semiaquilus, new species

FIGURES 5 and 6

HOLOTYPE.—SU 55939, standard length 60.9 mm., collected during December of 1960 by Harald Schultz from Igarapé Preto, according to Mr. Schultz, "a small jungle-rivulet at the headwaters of the black-water creeks, which empty in the upper Solimoes, State of Amazonas, Brazil. These small and narrow creeks have crystal clear water, sandy bottom, covered with pebbles, leaves and rotten leaves."

ADDITIONAL SPECIMENS.—USNM 196170, standard length 59.1 mm.; SM 5349 damaged but standard length about 54 mm. Both with the same data as the holotype.

DIAGNOSIS.—*Corydoras semiaquilus* may be distinguished from other species of *Corydoras* by the following combination of characters: It has a long snout (snout length about 32 to 33% of body length without head). Least caudal peduncle depth about 49 to 51% of snout length. Most species of *Corydoras*, except for the long snouted species, have the least depth of the caudal peduncle and the snout length about equal. Imbricated thoracic and abdominal plates present. Dorsal fin spine considerably weaker and shorter than pectoral fin spine. Predorsal length about 85 to 86% of distance between dorsal fin origin and caudal fin base. Caudal fin heavily barred.

DESCRIPTION.—(See table 1 for measurements.) For explanation of descriptive pattern below, see p. 117. SU 55939 is given first, USNM 196170 follows in brackets. Measurements of SM 5349 are not given because the head is badly damaged, making accurate measurements impossible.

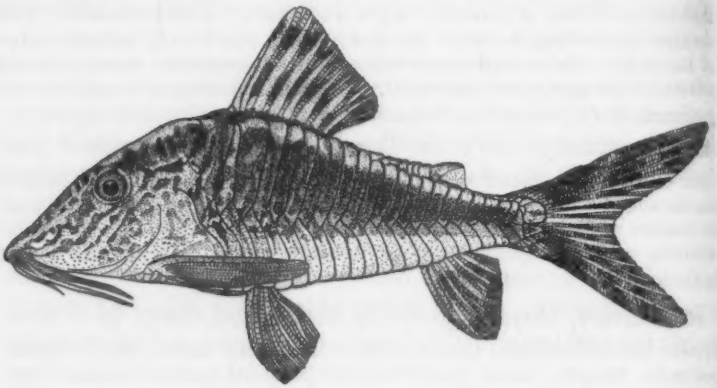

FIGURE 5.—*Corydoras semiaquilus*, new species, holotype, SU 55939. Standard length 60.9 mm.

Body relatively elongate, greatest body depth 3.0 (33.5%) [3.0 (33.5%)]. Least depth of caudal peduncle 8.9 (11.2%) [8.6 (11.7%)]. Dorsal fin origin nearer snout tip than caudal fin base. Distance between snout tip and dorsal fin origin 2.0 (50.7%) [2.1 (48.2%)]. Distance between snout tip and anus 1.9 (52.8%) [1.9 (52.5%)]. Anal fin origin to snout tip 1.2 (81.5%) [1.2 (80.4%)]. Lateral scutes 24/21 [26/23]. Abdomen entirely covered with small to moderate-sized imbricated bony plates. Azygous middorsal scutes 7 [6] anterior to adipose fin and 1 [1] anterior to dorsal fin. Pectoral fin base incompletely surrounded by coracoid. Distance between coracoids 8.5 (11.8%) [9.0 (11.2%)]. Head length 3.0 (32.9%) [3.0 (33.2%)]; greatest head width 1.5 (65.5%) [1.5 (64.8%)] in its length. Least width of bony interorbital 4.1 (24.6%) [3.9 (25.5%)] in head length. Snout acute in dorsal view but snout tip rather broadly rounded. Snout 1.4 (69.5%) [1.4 (69.5%)] in head length. Dorsal profile of snout concave in both specimens. When directed posteriorly, both rictal barbels reach a point on a vertical line passed down from posterior eye margin. Greatest diameter of orbit 4.4 (22.5%) [4.4 (22.9%)] in head length. Greatest width of suborbital 2.8 (35.6%) [1.8 (55.5%)] in orbit.

Dorsal fin I,7, in all specimens, last fin ray split to its base. Neither first spine nor first soft ray of dorsal fin reaches base of adipose spine when dorsal fin depressed. Dorsal fin spine much slenderer and shorter than pectoral fin spine. Adipose spine 1.5 (66.7%) [1.3 (77.8%)] in orbit. Anal fin ii,5, in all specimens, last ray split to base in SU 55939 and SM 5349 and not split to its base in USNM 196170. Pectoral fin I,11, in SU 55939 and USNM 196170, I,10, in SM 5349. Pelvic fin rays i,5, in all specimens. Caudal fin with principal rays 7/7 in all specimens. Pectoral fin spine (fig. 6) has 26 [24] spinules along its posterior border. There are 22 spinules in SM 5349.

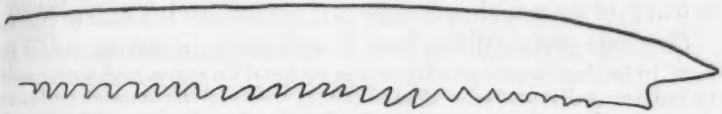

FIGURE 6.—*Corydoras semiaquilus*, new species. Pectoral fin spine of holotype, ventral view, left spine.

COLOR.—The holotype has the following color in alcohol (see also fig. 5): Ground color white to pale brown. Head with punctate to vermiculate dark brown or black markings, more punctate over snout and between eyes. Sides of head with black to gray markings. Belly, thorax, and lower one-third of body white. Upper two-thirds of body dark except for narrow streak of pale brown below dorsal fin. This pale area extends posteriorly to caudal fin above dorsal margin of body. Dorsal fin with two rather irregular black bars; caudal fin with three irregular black vertical bars. Anal fin with two black bars. Pelvic fins colorless except for some scattered melanophores over central portions of rays. Basal two-thirds of pectoral fin rays dark and entire pectoral fin spine dark. Color of paratypes very similar to that of holotype.

Color in life (from a Kodachrome) as follows: Dark areas seen in figure 5 black with slight suggestion of blue and purple. Greenish iridescence over lateral part of coracoid bone and golden iridescence over opercular bone. Pale areas of body very pale brown, somewhat pinkish in thoracic and abdominal regions while pale strip along dorsal edge of body somewhat darker brown. Iris around pupil golden, shading to black at edge of eye.

The name "semiaquilus" is from Latin (semi=half and aquilus=dark colored) referring to the dark color on the upper body scutes.

DISCUSSION.—The relationships of *Corydoras semiaquilus* seem to be clearly the long-snouted *Corydoras* such as *treitlii*, *acutus*, *cervinus*, *fowleri*, *pastazensis*, and *septentrionalis*. So far as known, it differs from all of these but *C. fowleri* in the possession of a thick layer of imbricated dermal plates on the abdomen and thorax. The species

appears closely related to *C. treitlii* because of its very long snout, its bony interorbital width contained twice or more in the snout length, its relatively slender caudal peduncle, and its color pattern. The obvious differences between *C. treitlii* and *C. semiaquilus* are the imbricated bony plates on the belly and thorax of the latter (the former has prickles only), a much longer pectoral spine in *C. semiaquilus* (see table 1 for comparison), a banded caudal fin in *C. semiaquilus* (caudal bands are absent in *C. treitlii*), and fairly consistent differences in caudal peduncle depth between the two species. The profile of the snout and dorsal part of the head is consistently different in *C. treitlii* and *C. semiaquilus*. *Corydoras treitlii* has the caudal peduncle depth 57.0 to 62.1% of the snout length while in *C. semiaquilus* it is 48.9 to 50.8%.

Corydoras cervinus differs from *C. semiaquilus* in lacking caudal fin bars, in having larger spinules on the pectoral fin spine, and apparently in lacking belly scutes. Rössel (1962) records the caudal peduncle depth for *C. cervinus* as 7 times in the standard length. In *C. semiaquilus* it is 8.6 to 8.9 times in the standard length.

Of the other known species with an interorbital contained twice or more in the snout, *Corydoras fowleri*, 2.2 (42.3%) in snout length, is very much like *C. semiaquilus* in the possession of imbricated thoracic and abdominal scutes and a somewhat similar color pattern. However, these two species differ widely with regard to several proportions. First, *C. fowleri* has a much shorter snout (about 24% of body length without head). Second, the head length of *C. fowleri* is 26.6% and that of *C. semiaquilus* is 32.9 and 33.2% of the standard length. Third, the eye of *C. fowleri* is proportionately smaller, being 6.1%, while that of *C. semiaquilus* is 6.6 to 7.4% of the standard length. Fourth and finally, the dorsal fin is placed farther anteriorly in *C. fowleri*, its predorsal length being 66.5% while that of *C. semiaquilus* is 85.2 to 85.5% of the distance between the origin of the dorsal fin and the caudal fin base. The color patterns of *C. fowleri* and *C. semiaquilus* actually may be quite similar; however, that of *C. fowleri* appears faded and, therefore, accurate comparisons cannot be made.

Another species, *Corydoras pastazensis* Weitzman (1963), is very closely related to *C. treitlii* and on the basis of specimens at hand, may be distinguished from *C. semiaquilus* by the following characters: *C. semiaquilus* has a body depth of 33.5% of the standard length while that of *C. pastazensis* is 36.4 to 37.1%. Body depth, being measured from the ventral border of the posterior coracoid process to the dorsal fin origin, is a stable measurement in *Corydoras*, little affected by the state of nutrition. Caudal peduncle depth of *C. semiaquilus* is 48.9 to 50.8% in the snout length while it is 65.2 to 66.4% in *C. pastazensis*. *Corydoras pastazensis* lacks the dark color pattern in the upper body scutes present in *C. semiaquilus* and lacks the marbled markings on the snout.

TABLE 1.—*Measurements of three* Corydoras *species*

Measurement	*Corydoras treitlii*				*Corydoras semiaquilus*		*Corydoras fowleri*
	Lectotype NMW 61103	NMW 47798	USNM 179612	SU 35054	Holotype SU 55939	USNM 196170	Holotype SU 16115
Standard length	42.6	42.4	52.5	44.2	60.9	59.1	66.0
Head length	14.2	14.3	17.5	15.1	20.0	19.6	17.5
Snout length	10.0	9.5	11.2	9.8	13.9	13.6	12.1
Least width of bony interorbital	4.4	3.6	5.6	4.3	4.9	5.0	5.6
Greatest diameter of bony orbit	3.7	3.1	4.3	3.9	4.5	4.5	4.0
Greatest width of suborbital	1.6	2.1	3.0	1.6	1.6	2.5	1.4
Length of fontanel	5.5	5.4	6.9	6.5	6.2	6.5	4.5
Length of predorsal scale	2.5	2.5	3.4	3.0	3.8	3.3	3.7
Greatest width of head	10.2	9.9	11.8	9.0	13.1	12.7	13.2
Snout tip to dorsal fin origin	24.0	20.8	26.8	23.1	30.8	28.5	28.6
Snout tip to anal fin origin	34.0	34.2	41.9	35.6	49.7	47.4	53.0
Snout tip to anterior edge of anus	22.5	23.3	27.3	22.0	32.2	31.0	32.7
Greatest body depth	14.8	15.1	18.8	15.2	20.4	19.8	20.3
Least depth of caudal peduncle	5.7	5.9	6.8	5.8	6.8	6.9	6.6
Distance between coracoids	3.9	4.6	4.7	3.3	7.2	6.6	8.5
Length of dorsal spine	9.1	8.6	10.2	10.0	10.8	10.6	?
Length of pectoral spine	8.9	8.5	11.6	10.0	14.2	13.9	16.7
Length of adipose spine	3.6	3.2	3.4	3.3	3.0	3.5	4.2
Origin of dorsal fin to caudal fin base	27.1	26.4	32.1	26.7	36.2	34.5	43.0
Post head length	30.9	29.9	37.4	31.3	42.7	41.5	49.8
Caudal peduncle length	6.3	6.0	7.3	5.9	8.5	8.3	9.8

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OSTEOLOGY AND RELATIONSHIPS OF SOUTH AMERICAN CHARACID FISHES OF SUBFAMILIES LEBIASININAE AND ERYTHRININAE WITH SPECIAL REFERENCE TO SUBTRIBE NANNOSTOMINA

By STANLEY H. WEITZMAN

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OSTEOLOGY AND RELATIONSHIPS OF SOUTH AMERICAN CHARACID FISHES OF SUBFAMILIES LEBIASININAE AND ERYTHRININAE WITH SPECIAL REFERENCE TO SUBTRIBE NANNOSTOMINA[1]

By Stanley H. Weitzman

Introduction

The present work is the result of an attempt to determine the relationships of two characid genera, *Nannostomus* and *Poecilobrycon*, to other members of the cypriniform family Characidae. The two genera include about eight known species of small characids found in forest brooks of South America. These species are here assigned to the subtribe Nannostomina. Although the first known species of this group was described in 1872, adequate investigation of morphological evidence for their relationships has never been undertaken. Previous investigations have been superficial in scope and often inaccurate in fact primarily because of the small size of these fishes. The total cranial length is usually 5–10 mm. and the largest recorded specimen is 44.5 mm. in standard length. In some cases, despite the lack of adequate morphological data, certain ichthyologists have

[1] This paper is the second of three parts based on a dissertation submitted to the Department of Biological Sciences, Stanford University, California, in partial fulfillment for the degree of Doctor of Philosophy. See Weitzman (1962) for the first part.

shown rather good intuitition in their interpretation of the relationships of these fishes; however, others have not been so fortunate in their interpretation and these fishes have been shifted about in the classification of characids until it is very difficult to obtain from the literature a concept of their affinities.

Investigation of *Nannostomus*, *Poecilobrycon*, and their relatives led to comparison of two widely divergent characid subfamilies, the Characinae, treated by Weitzman (1962), and the Lebiasininae, treated here. In addition the Erythrininae, another divergent subfamily of the Characidae, are compared with the Lebiasininae because these two groups of characids often have been thought to belong to a single group. Although the work began as an effort to determine the relationships of *Nannostomus* and *Poecilobrycon*, its most important result concerns the relationships of the subfamilies Lebiasininae and Erythrininae.

The morphological data obtained in the present study has resulted in the following classification, the names given below being used throughout this paper (see pages 148 to 152 for a full treatment of the classification):

Subfamily Lebiasininae
  Tribe Lebiasinini
  Tribe Pyrrhulinini
    Subtribe Pyrrhulinina
    Subtribe Nannostomina
Subfamily Erythrininae

For the loan of specimens, I am indebted to Dr. George S. Myers of Stanford University, Mr. W. I. Follett of the California Academy of Sciences, Dr. James Böhlke of the Academy of Natural Sciences of Philadelphia, and Mr. Loren P. Woods of the Chicago Natural History Museum. I am indebted especially to Dr. George S. Myers for critically reading much of the manuscript and offering aid and advice during most of its preparation. In addition, the following persons have read the manuscript at various stages, all providing very useful help: Mrs. Lillian Dempster of the California Academy of Sciences, Drs. Myra Keen and Warren Freihofer of Stanford University, and Drs. Leonard P. Schultz, Robert H. Gibbs, Jr., and Victor G. Springer of the U.S. National Museum.

The work was done at the Department of Biological Sciences, Division of Systematic Biology of Stanford University, at the Department of Anatomy, Stanford University School of Medicine, and at the U.S. National Museum, Smithsonian Institution.

Material Examined

This study is based on the examination of the skeletal preparations listed below. All specimens are alizarin preparations unless otherwise noted. In addition, considerable reference has been made to osteological preparations listed in Weitzman (1962, pp. 11–17). The methods of preparing specimens for osteological investigation are the same as those I used earlier (Weitzman, 1954; 1962).

The osteological drawings of *Poecilobrycon harrisoni* Eigenmann are based on one specimen (Stanford University 50245), 36.4 mm. in standard length. This specimen, together with eleven others, was found in the collections of the Division of Systematic Biology of Stanford University. These specimens had no data other than "British Guiana, Georgetown." Six additional aquarium-reared specimens (Stanford University 50244), 9.5 to 21.0 mm. in standard length, were stained with alizarin and compared with the specimen used for drawing. Since general proportions and shapes in the osteological drawings were delineated by optical methods, some distortion can be found in the figures. This is especially noticeable in figures 2–6, wherein the anterior cranial and snout region is somewhat foreshortened. All illustrations are by the author.

In the list below, CAS refers to the California Academy of Sciences; CAS(IUM) refers to specimens belonging to the California Academy of Sciences but previously deposited at Indiana University and still bearing an Indiana University number; SU refers to specimens belonging to the Division of Systematic Biology, Department of Biological Sciences, Stanford University; USNM refers to the United States National Museum; ANSP refers to the Academy of Natural Sciences of Philadelphia.

Copeina guttata (Steindachner): SU 51692, two (of four), SL 56.5–57.0 mm., Peru, creek near Yurimaguas, November 1920, W. R. Allen.

Copella nattereri (Steindachner): CAS 20743, four (of 35), SL 23.5–35.5 mm., Brazil, State of Pará, Lagôa Grande [probably Lagôa Grande do Javari about 35 mi. northwest of Santarém] July 17, 1924, Carl Ternetz.

Erythrinus erythrinus (Bloch and Schneider): SU 57678, four, SL 52.0–99.5 mm., Peru, creek near Yurimaguas, November 1920, W. R. Allen.

Hoplerythrinus unitaeniatus (Agassiz): CAS(IUM) 17106, one (of four), SL 97.0 mm. Bolivia, Cuchuela [Cachuela] Esperanza, March 1922, N. E. Pearson; USNM 163188, one (of four), SL 86.9 mm., Venezuela, a few miles off Puerto Ayacucho, "Amazon territory," March 13, 1950, J. A. Rivero.

Hoplias malabaricus Bloch: CAS(IUM) 17107, five, SL 31.0–108.0 mm., Bolivia, Huachi, at junction of the Río Bopi and Río Cochabamba [Santa Elena], Río Beni basin, September–October 1921, N. E. Pearson; SU 3106, one, dry skeleton, cranium 31 mm. in total length, Brazil, Marajó Island, Río Tocantins, C. F. Hart.

Lebiasina bimaculata Valenciennes: CAS(IUM) 15171, three (of 30), SL 57.5–60.9 mm., Peru, Piura, January 11, 1919, Carl H. Eigenmann.

Nannostomus beckfordi Günther: SU 50258, six (of 44), SL 22.0–26.5 mm., originally from SU 50257, Brazil, State of Pará, south bank of Río Amazonas, "Río Urara," June 26, 1924, Carl Ternetz.

Nannostomus digrammus Fowler: SU 50249, two, SL 16.3–19.4 mm., Brazil, State of Amazonas, Manaos [Manaus], 1865, Louis Agassiz; SU 50251, three, SL 18.0–22.8 mm., Brazil, State of Amazonas, Igarapé do Mãi Joana, a tributary of the Rio Negro near Manaos [Manaus], December 25, 1924, Carl Ternetz.

Nannostomus espei (Meinken): ANSP 73873, one, SL?, British Guiana, an unnamed creek, tributary to the Paruma River, itself tributary to the Mazaruni River via the Kamarang River, Pakaraima Mountain region of western British Guiana, 1955, Louis Chung; SU 50252, one, SL 25.0 mm., aquarium specimen, locality data unknown but probably the same as ANSP 73873.

Nannostomus marginatus Eigenmann: SU 54119, three (of 32), SL 19.0–21.5 mm., originally from SU 50219, Brazil, State of Pará, Lagôa Grande [probably Lagôa Grande do Javari about 34 mi. northwest of Santarém], August 20, 1929, Carl Ternetz.

Nannostomus trifasciatus Steindachner: SU 50223, one, SL 29.5 mm., British Guiana, no other data; SU 54130, one (of two), SL 31.5 mm., aquarium specimen, "from the Amazon," sent to G. S. Myers by Frederick Stoye.

Piabucina festae Boulenger: SU 51068, four (of 12), SL 60.5–71.5 mm., Colombia, Río Truandó, a western tributary of the Río Atrato near Río Sucio, 1913, C. E. Wilson; USNM 167795, one (of six), SL 70.0 mm., same data as preceding.

Piabucina panamensis Gill: USNM 109234, two (of seven), SL 77.7–84.0 mm., Panama, Cativá, March 2, 1937, S. F. Hildebrand.

Piabucina erythrinoides Valenciennes: USNM 121400, three (of 27), SL 35.1–101 mm., Río Chama at Estanques, State of Mérida, Venezuela, April 3, 1942, L. P. Schultz.

Piabucina species?: USNM 123796, two (of six), SL 64.1–67.3 mm., Colombia, Río Magdalena, Cecil Miles.

Poecilobrycon eques (Steindachner): SU 50247, two (of five), SL 28.5–30.0 mm., originally from SU 50229, Brazil, State of Amazonas, São Gabriel [Uaupés], Río Negro, rockpools below rapids, February 1, 1925, Carl Ternetz; SU 50224, three, SL 25.8–32.5 mm., aquarium specimens, no other data.

Poecilobrycon harrisoni Eigenmann: SU 50246, one, SL 29.5 mm., originally from SU 50245, British Guiana, Georgetown, collector unknown; SU 50245, one (10 unstained), SL 36.4 mm., British Guiana, Georgetown; SU 50244, six, SL 9.5–21.0 mm., aquarium specimens, reared by S. Weitzman.

Poecilobrycon unifasciatus (Steindachner): CAS(IUM) 11704, one (of 10), SL 33.0 mm., British Guiana, Rockstone sandbank, Essequibo River, 1908, C. H. Eigenmann; SU 50268, two, SL 27.8–30.4 mm., aquarium specimens, no other data.

Pyrrhulina filamentosa Valenciennes: CAS(IUM) 12186, four, SL 14.7–20.2 mm., British Guiana, Aruka River, 1908, C. H. Eigenmann.

Pyrrhulina semifasciata Steindachner: CAS(IUM) 12172, one, SL 58.1 mm., British Guiana, Holmia Creek, 1908, C. H. Eigenmann.

Pyrrhulina spilota Weitzman: USNM 197523, two (of 19), SL 41.5–50.4 mm., first generation descendants of holotype and paratype.

Pyrrhulina vittata Regan: USNM 197524, SL 26.0 mm., aquarium specimen, locality unknown.

Historical Review of the Classification of *Nannostomus* and *Poecilobrycon*

Günther (1872, p. 146) described the first member of the Nannostomina, *Nannostomus beckfordi*. Of its relationships with other characids, he simply stated: ". . . allied to *Lebiasina*, but with a totally different form of the snout and mouth." He considered it to belong to his first group of characids, the Erythrina (Günther 1864, pp. 278 and 281), which included the genera *Hoplias*, *Erythrinus*, *Lebiasina*, *Pyrrhulina*, and *Corynopoma*. They were defined as those characids without an adipose fin.

Steindachner (1876, p. 130) thought *Nannostomus* should be placed in or near the group Anostomatina [2] of Günther (1864, pp. 279, 303). Günther's Anostomatina included the genera *Anostomus*, *Rhytiodus*, and *Leporinus*. Steindachner (1876, p. 122) pointed out that the presence or absence of the adipose fin in *Nannostomus* (=*Nannostomus* plus *Poecilobrycon* of later authors) is not of importance in determining their relationships with other characids because this fin may be present or absent in specimens of *Poecilobrycon eques*.

Eigenmann and Eigenmann (1891, p. 49) placed *Nannostomus* in their subfamily Anostomatinae, which also included *Anostomus*, *Laemolyta*, *Characidium*, *Rhytiodus*, *Leporellus*, and *Leporinus*. Boulenger (1904, p. 576), following Steindachner's and Eigenmann's precedent, placed the genus *Nannostomus* in the subfamily Anostominae.

Eigenmann (1909b, p. 35–36) placed the genera *Nannostomus*, *Poecilobrycon*, and *Archicheir* (the latter two therein described) in his undefined subfamily Nannostomatinae; however, the name Nannostomatinae first appeared in Eigenmann (1909a). He also included the genera *Characidium* and *Microcharax* in this subfamily. Eigenmann (1910, p. 427) again listed his subfamily Nannostomatinae and, in addition, included the genus *Jobertina*. Eigenmann may have held the opinion that the members of his subfamily Pyrrhulininae are allied to *Nannostomus* and *Poecilobrycon* for he placed them immediately after his Nannostomatinae. These two subfamilies were separated widely from his Erythrininae. Eigenmann's Anostomatinae (including *Leporinus* and relatives) immediately preceded his Nannostomatinae. Apparently at that time he thought them related. Eigenmann (1912, p. 254), in a key to the subfamilies of characids from British Guiana, first defined the subfamily Nan-

[2] According to Miller (1897, p. 132), family group names formed from adjectives used substantively, e.g., *Nannostomus* and *Anostomus*, should not be terminated by "-atidae" or "-atinae." Accordingly, Günther's *Anostomus* should become Anostomina, not Anostomatina, or Anostominae, not Anostomatinae.

nostomatinae. There are three important errors in Eigenmann's concept of this subfamily's morphology. Teeth are present in the maxillary, not absent; the gill membranes are joined to each other but free from the isthmus, not slightly united; and the parietal fontanel is absent, not present as Eigenmann indicated.

Regan (1911, p. 21) placed the genera *Nannostomus* and *Characidium* in the Nannostominae and included this subfamily in his family Hemiodontidae. This family consisted only of his Hemidontinae and Nannostominae.

Cockerell (1914, p. 98–99), in a study of characid scales, noted the close resemblance of the scales of *Nannostomus* and *Pyrrhulina* and, on this basis alone, found reason to more closely associate *Pyrrhulina* with *Nannostomus* than *Poecilobrycon* with *Nannostomus*. He also noted the very different structure of the scales of *Characidium*. I find that the scales of *Poecilobrycon* and *Nannostomus* are much alike and, in addition, are very similar to those of *Pyrrhulina*, *Copella*, and *Copeina*. In confirmation of part of Cockerell's work, however, the osteology and scales of *Characidium* differ quite widely from the osteology and scales of any of the other genera discussed here.

Gregory and Conrad (1938, pp. 324, 344–347) followed Regan (1911) in relating *Nannostomus* and *Poecilobrycon* to *Hemiodus* and its relatives. They placed *Nannostomus* and *Poecilobrycon* in a subfamily (Hemiodontinae) considered by them to be widely separated from the subfamily (Characinae) containing *Pyrrhulina*. As shown below, my work indicates that *Nannostomus*, *Poecilobrycon*, and *Pyrrhulina* are related rather closely and are placed in the tribe Pyrrhulinini.

Fowler (1950, pp. 253–263) considered the genera *Characidium*, *Microcharax*, *Nannostomus*, *Archicheir*, and *Poecilobrycon* as constituting the subfamily Nannostominae (apparently following Eigenmann, he spelled it Nannostomatinae). He placed this subfamily nearest his subfamilies Leporininae and Parodontinae but did not comment on relationships or define his groups.

Hoedeman (1950a, p. 14) established the tribe Nannostomini to include the genera *Nannostomus*, *Poecilobrycon*, and his newly proposed *Nannobrycon*. He apparently did not consider that the genus *Archicheir* belonged to his Nannostomini, for he excluded it from his treatment.

In his first paper on *Nannostomus* and relatives, Hoedeman (1950a, p. 11) considered his Nannostomini to be related to the Hemiodontinae; however, he excluded *Characidium* from relationship with the Hemiodontinae. He presented no evidence for this opinion. Hoedeman (1954a, p. 83) reconsidered his classification and placed the tribe (emended to Nannostomidi) in his family Erythrinidae, a family he

then considered as comprising two subfamilies, Erythrininae and Anostominae. He here excluded the Hemiodontinae from his Erythrinidae. His subfamily Erythrininae comprised four tribes, Lebiasinidi, Erythrinidi, Pyrrhulinidi, and Nannostomidi. He did not present evidence for this classification but he did remark (words in brackets are mine): "*Poecilobrycon* cannot be derived from either of these genera [i.e., *Nannostomus* or *Nannobrycon*], nor vice versa. The two groups probably had a common ancestor, close to the present day *Pyrrhulina*, to which both are more closely related than to each other." Hoedeman, however, placed *Poecilobrycon*, *Nannostomus*, and *Nannobrycon* in one group and the *Pyrrhulina* in another. As will be shown below, it is my opinion that the members of the Nannostomina as defined below are more closely related to each other than to any other characids, but that Hoedeman was correct at that time in suspecting their relationship to be with *Pyrrhulina*. Hoedeman (1954b, pp. 68–84, and 1956b, pp. 547–551), however, once again reconsidered his classification of *Nannostomus* and *Poecilobrycon* and placed them with *Hemiodus* and relatives, excluding them from close realtionship with *Pyrrhulina*.

In summary, the Nannostomina have been thought to be related to *Lebiasina* and its relatives, *Erythrinus* and its relatives, *Pyrrhulina* and its relatives, *Characidium*, and finally to *Hemiodus* and its relatives. As will be shown, their morphological relationships are with *Pyrrhulina*, *Lebiasina*, and close relatives. Inadequate morphological investigations have been the primary cause of this divergence of opinion.

Historical Review of the Classification of the Erythrininae and Lebiasininae

Since in the present work *Nannostomus* and *Poecilobrycon* have been found to belong to the subfamily Lebiasininae, a historical review of their relationships to other characids would not be complete without a historical review of the Lebiasininae. Because the Lebiasininae and Erythrininae have been associated closely by many authors, both are reviewed.

Valenciennes, in Cuvier and Valenciennes (1846, p. 480), established the "famille des Erythroides" for the reception of the genera *Macrodon* (=*Hoplias*), *Erythrinus*, *Lebiasina*, and *Pyrrhulina*. He defined these fishes as having a double swim bladder that is sometimes cellular, teeth on their jaws and palate, the cheek covered by a large subopercle, the belly always rounded, and no pyloric caeca. Apparently, Valenciennes interpreted the small autogenous "supraopercular" element of *Hoplias* as the opercle and the large true opercle as the subopercle.

Günther (1864, pp. 278, 281–288) added the genus *Corynopoma* to Valenciennes' family grouping. This genus originally was considered by Gill (1958, pp. 422–428) to have affinities with the Characinae. Regan (1906, p. 382; 1911, p. 16) has shown good reasons for not placing *Corynopoma* with the genera *Hoplias*, *Erythrinus*, and *Hoplerythrinus*.

Gill (1858, pp. 410–413) established the family Erythrinidae for *Pyrrhulina*, *Erythrinus*, and *Lebiasina*. Eigenmann and Eigenmann (1889, pp. 100–115) followed Günther (1864) in including *Corynopoma* in what otherwise essentially equals Gill's family Erythrinidae. Neither Günther nor Eigenmann and Eigenmann had seen examples of Gill's *Corynopoma*. The Eigenmanns, however, chose to give the group subfamily rank (Erythrininae) within the Characidae. The Eigenmanns listed characters for the Erythrininae as follows:

> Adipose fin none. Gill opening wide, the membranes slightly united, free from the isthmus. Nares approximated. Teeth well developed, at least in the jaws; pharyngeal teeth villiform. Cheeks covered by the suborbital bones. Brain case entirely closed above. Body elongate, slender, fusiform or subfusiform. Back not greatly arched, belly rounded. Dorsal short, of 8 to 15 rays. Intestine short. Carnivorous.

This definition does not exclude all members of the Characinae or members of some of the other subfamilies of characids.

Regan (1911) included all the members of Gill's Erythrinidae in his Characidae; however, he separated *Pyrrhulina* widely from *Lebiasina* and *Piabucina* because he found that *Pyrrhulina* lacked ectopterygoid teeth while *Lebiasina* and *Piabucina* possessed them. Examination of many characids indicates that the presence or absence of ectopterygoid teeth is of minor importance because, in some species that normally possess them, they may be unilaterally or bilaterally absent in a few specimens. They may also be present in one species but absent in otherwise closely related species, e.g., *Charax* and its relatives.[3]

Regan (1911) maintained *Erythrinus*, *Hoplerythrinus*, and *Hoplias* in the subfamily Erythrininae and the genera *Lebiasina* and *Piabucina* in the subfamily Lebiasininae. He placed *Nannostomus* and *Poecilobrycon* in his Hemiodontidae because their premaxillaries are movable, because he thought they had no ectopterygoid teeth, and because he misinterpreted the palatine arch.

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[3] The establishment of the family Acestrorhynchidae by Fernandez-Yepez (1955, p. 450) and the genus *Charaxodon* by Fernandez-Yepez (1947, p. 1), based principally, if not wholly, on the presence or absence of ectopterygoid teeth (= the teeth of the "palatine" of Fernandez-Yepez) should be reviewed with a more critical approach. Böhlke (1958, p. 70) considered *Charaxodon* to be a synonym of *Moralleszia*.

Regan (1912) lumped the genera *Chalceus*, *Pyrrhulina*, *Copeina*, and *Pogonocharax* into a "natural group," stating that they differed from the rest of the Characidae by a very large mesethmoid (= ethmoid of this work), oblong or elongate body form, rounded abdomen, flattish upper surface of the head, large scales, and short dorsal and anal fins. These are superficial characters and do not indicate true relationships. The osteology of *Chalceus* appears to be in many respects like that of *Brycon* and there is reason to believe that *Chalceus* may have been derived from *Brycon* or a very close ancestor. In any event, its osteology is typically that of the Characinae as defined by Weitzman (1962). The case of *Pogonocharax rehi*, a fish described by Regan and presumed by him to be from South America, was reviewed by Myers (1956b, p. 13); the fish is not a characid but an Asiatic cyprinid of the genus *Esomus*.

Gregory and Conrad (1938, pp. 324, 343–344) recognized the subfamily Erythrininae for the inclusion of the Erythrininae and Lebiasininae of Regan (1911). Superficially, Regan's two subfamilies do look much alike but they are separated by the characters listed below in the classification. Gregory and Conrad (1938, p. 343) have noted the resemblance of *Hepsetus* (= *Sarcodaces*) to *Hoplias;* indeed, *Hepsetus* possesses a supraopercular like *Hoplias*. The cranial bones do have a superficial and perhaps even a phylogenetically significant resemblance to those of *Hoplias*. Basically, however, the osteology of *Hepsetus* is more like that of the Characinae, especially with regard to the pectoral girdle. In addition, *Hepsetus* has four branchiostegal rays, a clear anastomosis between the dermopterotic and supraorbital laterosensory canals, no accessory ectopterygoid, and the usual characid number of eight orbital bones. Certain features of the skull, however, such as the frontal-sphenotic articulation and the presence of a supraopercular are characters in common with the Erythrininae but not the Characininae and suggest that the relationships of *Hepsetus* should be investigated further. In addition, the possible relationships of *Ctenolucius* and *Boulengerella* with *Hepsetus* should not be neglected. Preliminary examination indicates that the relationships of *Acestrorhynchus* and *Acestrorhamphus* are probably with *Charax*, *Roeboides*, and other closely related genera in the Characinae, not with *Boulengerella* and *Ctenolucius* as assumed by Gregory and Conrad (1938, pp. 323–324, 338–344). These authors followed Regan (1911) in placing *Nannostomus* and *Poecilobrycon* with members of the Hemiodontinae.

Hoedeman (1954b, p. 55; 1956a, p. 12) presented a classification of the major characid groups. Most of his work appears to be speculation. The only morphological data of any value was a superficial comparison of scales from several characids. In his 1956 classification, Hoedeman

separated characids into three families, one of which was the Erythrinidae. He divided this family into two subfamilies. The first, the Erythrininae, contains his Lebiasinidi (= Lebiasinini of the present work), Erythrinidi (= Erythrininae), Pyrrhulinidi (= Pyrrhulinina) and Nannostomidi (= Nannostomina). The second subfamily of Hoedeman's Erythrinidae is the Anostominae. In this group he placed four tribes, Curimatidi, Anostomidi, Hemiodontidi, and Prochilodidi. Hoedeman (1956a, p. 12) stated:

> Vers le milieu de l'eocene, les Erythrinidae se divisent en deux sous-familles: (a) Erythrininae, avec les tribus actuelles: (1) Lebiasinidi, (2) Erythrinidi, (3) Pyrrhulinidi, et (4) Nannostomidi; et la seconde sous-familles: (b) Anostominae, avec les tribus: (5) Curimatidi, (6) Anostomidi, (7) Hemiodontidi, et (8) Prochilodidi.

There is no fossil evidence for this statement nor is there fossil evidence for any of the other of Hoedeman's phylogenetic and time-sequence inferences and speculations given in his paper.

Piton (1938) described two fossil fishes from the mid-Eocene at Menat, France. Piton thought that these fishes, *Prohydrocyon pellegrini* and *Procharacinus arverniensis*, were fossil characids. Perhaps Hoedeman's use of the date of mid-Eocene is from Piton's paper. It appears now that there is no evidence for characids from the mid-Eocene of France (Weitzman, 1960).

The original evidence presented by Hoedeman (1956a) for his phylogeny was apparently derived from examination of a few representative characid scales. Examination of characid scales of the genera listed in the material section of Weitzman (1962) shows a greater variation in the scale morphology of characid groups than Hoedeman found. Sufficient variation was found among the representatives of the various groups to indicate that, although scales will prove useful as an aid in establishing a classification and for drawing phylogenetic inferences, their use alone, without an attempt to correlate them with many other morphological characters, may more often prove misleading than helpful.

Osteology of *Poecilobrycon harrisoni* and Related Characids

In the osteological discussion below, parts of the skeleton of *Poecilobrycon harrisoni* are described and compared with other species of *Poecilobrycon* and *Nannostomus*. Also, other characid genera and groups thought, either by the present author or other authors, to be pertinent to a discussion of the relationships of the Nannostomina are compared with the basic skeletal plan of *Nannostomus* and *Poecilobrycon*.

CRANIUM (figs. 2, 3, 4, 5, 6).—The median ethmoid bone is a large, rather thin plate that has a profile in dorsal view as shown in figure 2.

This bone has bilateral posterior lamellae projecting backward under the frontals and contacting the dorsoanterior portion of each lateral ethmoid. The ethmoid probably is mostly of supraethmoidal (dermethmoidal) origin, but an anterior, ventral lamella of the ethmoid that extends inferiorly and posteriorly to contact the prevomer below is probably of endochondral origin. The ethmoidal spine found in most characids (see Weitzman, 1962, figs. 2, 3, 4 of *Brycon meeki*) is reduced to a very small structure. The premaxillaries are not firmly attached (the joint being a loose syndesmosis) and are somewhat movable, being attached to the ethmoid by fairly long, lax ligamentous tissue. They cannot, however, be described as protractile. The cartilagenous part of the ethmoid is restricted to the area between the large prevomer and the ethmoid. A few foramina are present on the dorsoanterior surface of the ethmoid. All species of *Nannostomus* and *Poecilobrycon* have a very similarly shaped ethmoid; however, members of the genus *Nannostomus* have a shorter snout and, therefore, a shorter, more blunt ethmoid than members of the genus *Poecilobrycon*.

The large ethmoid of the genera *Pyrrhulina*, *Copella*, and *Copeina* is very similar to that in the Nannostomina in its relationships to the prevomer, lateral ethmoids, and frontals. It differs, however, in having a broader, more rounded horizontal profile and a very well-developed, though rather obtuse, ethmoidal spine. In the Pyrrhulinina the premaxillaries are attached to the ethmoid by a very slightly movable syndesmotic fibrous joint. The ethmoid of *Lebiasina* and *Piabucina* is generally similar in structure to that of *Pyrrhulina*, *Copella*, and *Copeina*, but proportionately the ethmoidal spine is considerably smaller.

The ethmoids of the Lebiasinini and Pyrrhulinina differ most prominently from those of the Nannostomina in the following manner: The ethmoidal spine is well developed, the premaxillary is firmly fixed to a groove along the anterolateral border of the ethmoid by a tight fibrous joint, and the ethmoid bone is not as oblong or square in horizontal profile, being somewhat more wedge-shaped.

The ethmoid of *Hoplias* (Starks, 1926, p. 160, fig. 8) and *Erythrinus* is quite similar in general form to that of *Brycon* (Weitzman, 1962); however, the joint between the ethmoid and prevomer is bordered by a lateral lamina of cartilage that is in contact with, or approaches, a mass of cartilage on the medial anterior border of the palatine (fig. 4). In the Characinae, only very small amounts of cartilage exist in these areas. The ventral diverging bony ethmoid lamellae, so well developed in the other characid fishes examined, are not at all, or only weakly, developed in the Nannostomina, only weakly so in the Pyrrhulinina and the Lebiasinini, but well developed in the Erythrininae.

The toothless prevomer is concave ventrally and concave dorsolaterally, being an inverted Y-shaped bone in cross section. In small specimens of *Poecilobrycon harrisoni* and in the large adults of some species (*Nannostomus beckfordi* and *N. trifasciatus*), the prevomer is formed of three thin concave plates of bone adhering to, or about, a central cartilaginous core. The two fused dorsal plates contact the ethmoid by a cartilaginous (synchondral) joint and posteriorly by another synchondral joint to the parasphenoid and lateral ethmoid. There is no rhinosphenoid. The posterior shaft of the prevomer, which ordinarily contacts the parasphenoid in the characinae, is extremely short and does not reach the parasphenoid. There are a number of foramina on the ventral surface of the prevomer. Many of these are probably for branches of the ramus buccalis facialis nerve.

Members of the Erythrininae, Lebiasinini, and Pyrrhulinina have a prevomer essentially like that of the Nannostomina; however, the shaft of the vomer is better developed in groups other than the Nannostomina and extends well back onto the parasphenoid. Except for the reduced prevomerine shaft in the Nannostomina, the prevomer of the Lebiasininae is essentially like that of the Characinae.

Each lateral ethmoid projects downward from under its respective frontal and contacts its counterpart at the median vertical plane by a nonmovable synchondral (cartilaginous) joint. The foramen for the olfactory nerve is near the median edge of the lateral ethmoid. An upper medial blade of the lateral ethmoid extends anteriorly and medially to contact a vertical median wall of cartilage behind the prevomer and there forms a nonmovable synchondral joint. Anteroventrally the lateral ethmoid has a process extending forward to contact a sheet of cartilage that extends anteriorly to the lower portion of the prevomer. Ventrally the prevomer is in contact through cartilage with the parasphenoid and posteromedially with the orbitosphenoid. The lateral ethmoid of all members of the Nannostomina and other members of the Lebiasininae is essentially the same. In the Pyrrhulinina and the Lebiasinini the distance between the prevomer and the lower medial portion of the lateral ethmoid is much shorter. That of young specimens of *Hoplias* is similar to that in the Nannostomina, but in older specimens the two bones meet each other. The structural configuration of the lateral ethmoid in the Erythrininae and Characinae is not markedly different in the two groups, and those differences in form that do occur can be correlated with differences in the shape of mouth and snout and their functions.

The frontals of *Poecilobrycon harrisoni* are large, smooth, gently curved bones. They are similar to the frontals of the Characinae in their basic structural relationship to other bones of the cranium; however, the frontal-parietal fontanel is never present in adults and

the epiphyseal bar is relatively small in size. In young specimens a well-developed fontanel is present. A specimen 14.8 mm. in standard length had a well-developed fontanel while a specimen 21.8 mm. in standard length had none. The supraorbital laterosensory canal in the frontal has the normal characid course but with the following exceptions: The portion of the canal that normally is buried in frontal bone over the epiphyseal bar (the mesial or epiphyseal branch) is reduced greatly in length, and the canal that in the Characinae passes backward in the frontal to the pareital (the posterior branch) is absent.

The distribution of major laterosensory canals is the same in the frontal of the Pyrrhulinina as in the Nannostomina although the mesial branch (supraorbital commissure of Branson and Moore, 1962) sometimes is developed better in the Pyrrhulinina. In *Piabucina* the posterior branch is present but it does not reach the parietal. In both *Lebiasina* and *Piabucina* there is a branch of the dermopterotic sensory canal extending backward in the lateralmost edge of the frontal. Posteriorly the dermopterotic canal enters the pterotic. Anteriorly this canal enters the infraorbital canal. In *Hoplias*, *Erythrinus*, and *Hoplerythrinus* the lateral edge of the frontal bone extends outward to contact the spinous process of the sphenotic, completely covering and encircling the dilator groove. This is not true in the Characinae, nor in the Lebiasinini, Pyrrhulinina, or Nannostomina. In these fishes the dilator groove is covered but not encircled by the frontal. Small specimens of *Hoplias* have the frontals and parietals separated by a fontanel, while adults do not. In *Hoplias* and *Erythrinus* the supraorbital sensory canal is the same as in the Nannostomina, but the posterior branch extends into the parietal.

The supraoccipital of *Poecilobrycon harrisoni* is not unlike that of *Brycon* in its position and relationships to other cranial bones. The supraoccipital of the Pyrrhulinina, Lebiasinini, and Erythrininae is quite similar to that of the Nannostomina and differs mainly from the Characinae in the replacement of the supraoccipital spine with a crest.

The exoccipitals, basioccipital, and epiotics of *Poecilobrycon harrisoni* are very much like those of the members of the Characinae and differ in a manner correlated with the widening and flattening of the skull. This may best be seen by comparing the illustration in Weitzman (1962, fig. 5) with figure 5 of the present work. The myodome is much reduced in its vertical depth. The exoccipitals, epiotics, and basioccipital of the Pyrrhulinina, Lebiasinini, and Erythrininae differ from those of the Characinae in having shapes similar to those of the Nannostomina.

The opisthotic is a small tabular bone applied to the joint between the pterotic and exoccipital but lying mostly on the pterotic.

Dorsally the pterotic is overlaid by the parietal and posteriorly contacts the epiotic. Anteriorly and dorsally the pterotic does not reach the frontal but is completely bounded by the sphenotic, while medially it contacts the prootic. Except for lacking a dermopterotic laterosensory canal, for not contacting the frontal, and except for its general shape, the pterotic is much like that of the Characinae. The pterotic of the Pyrrhulinina is like that of the Nannostomina in lacking a laterosensory canal and in not being jointed with the frontal. The Lebiasinini and the Erythrininae have a laterosensory canal in the pterotic and the frontal contacts the sphenotic.

The sphenotics are much like those of the Characinae; their various relationships to other bones have been described under the frontals and parietals. Their relationships to the semicircular canals are the same as in the Characinae.

In their essential relationships to other bones and the soft anatomy, the prootics are not greatly different from those of the Characinae. Detailed comparison of the various foramina of this bone with the foramina of the prootics of the Pyrrhulinini, Lebiasinini, and Erythrininae undoubtedly would prove productive in determining relationships; however, this work must be postponed pending detailed studies of the nerves, veins, and arteries passing through this complicated bone.

The subtemporal fossa is present as a shallow groove along the joint between the prootic and pterotic and is present in all members of the Erythrininae and Lebiasininae.

The pterosphenoid of *Poecilobrycon harrisoni* and other species of the Nannostomina is similar to that in the Characinae, being a large plate in the upper posterior wall of the orbit. The foramen for the trochlear nerve is located at the junction of the articulation between the frontal, pterosphenoid, and orbitosphenoid.

The orbitosphenoid is Y-shaped in cross section; the upper arms of the Y are jointed to the frontals. A foramen for the first cranial nerve is enclosed partially by the orbitosphenoid. Other species in the Nannostomina examined also have an orbitosphenoid that is Y-shaped in cross section. The same is true of the Pyrrhulinina. In the Lebiasinini the cross sectional shape of the orbitosphenoid is more like a V than a Y. In *Hoplias* the foramen for the first cranial nerve is included completely in the orbitosphenoid of adults but included only partially in that of the young. *Erythrinus* has a rather peculiar orbitosphenoid, consisting of a pair of bilateral flat plates attached ventrally by cartilage. In specimens larger than those examined these plates possibly may fuse ventrally, producing a more

"normal" orbitosphenoid. The orbitosphenoid does not have a foramen for the first cranial nerve in the small specimens of the Erythrininae examined, but it may, in larger specimens. An X-ray negative of a specimen of *Hoplias*, 108 mm. in standard length, indicates that a foramen may be included partially in the orbitosphenoid.

ORBITAL BONES (fig. 6).—There are six infraorbital bones in the Lebiasininae and Erythrininae. The supraorbital is absent. The first and second infraorbitals in adult specimens of *Poecilobrycon harrisoni* have a laterosensory tube imbedded within them. The remainder of the infraorbital bones have the infraorbital canal along their ocular edge but it is enveloped only partially in bone. Only *Poecilobrycon eques*, *P. harrisoni*, and *P. unifasciatus* have a sensory tube contained within the bony substance of both the first and second infraorbitals. All other known members of the Nannostomina lack this bony tube in the second infraorbital, the infraorbital canal passing over the surface of the bone. The antorbital is present and well developed in the Nannostomina; it sometimes partially envelops the anterior part of the infraorbital canal. In the Pyrrhulinina the first two infraorbital bones have enclosed canals; sometimes the other infraorbital bones also have enclosed canals in members of this subtribe.

In the Lebiasinini the infraorbital canal may be included within the bony substance of all the orbital bones or it may pass only over the surface of the second through the fifth infraorbital. It may pass either within or over the substance of the antorbital.

In the Erythrininae the orbital bones have an infraorbital canal imbedded in them. There is no supraorbital; the antorbital contains a canal and is fused with the first infraorbital. This is apparently similar to the situation found in certain cyprinodonts and catfishes (see Weitzman, 1962, pp. 28–31). Another possible interpretation is that the antorbital is absent, the first infraorbital having extended into the topographical area of the antorbital.

The elongate nasal bone of the Nannostomina has the usual characid relationship, being a tubular bone connected with, and anterior to, the supraorbital canal of the frontal. In the Pyrrhulinina, Lebiasinini, and the Erythrininae the nasal bone is not greatly different from that of the Nannostomina except for differences correlated with the broader and shorter snouts in these fishes.

OPERCULAR APPARATUS (figs. 6, 7).—The opercular bones of the Nannostomina differ from those of the Characinae mainly in having a different shape correlated with the elongate and relatively flattened head. The thin interopercle internally covers much of the lower surface of the symplectic, preopercle, metapterygoid, and even some of the quadrate. The preopercle does not extend forward to near the

mandible as it does in the Characinae, Pyrrhulinini, Lebiasinini, and Erythrininae, but it is limited in its anterior extent to an area under the long, slender, lower, posterior process of the quadrate. The opercle and subopercle are similar in Lebiasininae and Erythrininae and are not markedly different from those of the Characinae.

Upper jaw (figs. 6, 7).—The premaxillaries of the Nannostomina bear a single row of one to seven small cuspid teeth. A row of "replacement" teeth is present behind the main outer row. The premaxillary is not divided into upper and lower processes but is more or less lenticular in its horizontal outline. Its dorsal surface has a depression to receive a lateral process of the ethmoid bone.

The maxillaries of all members of the Nannostomina are essentially alike. The maxillary has a single tooth with from one to six cusps. The maxillary is a flat lamella of bone with a robust, conic upper process extending toward the anterior part of the ethmoid. Posteriorly the maxillary does not reach the second infraorbital.

The premaxillary of the Pyrrhulinina bears one to two rows of simple conic teeth while the maxillary has a single row of conic teeth along its edge. The maxillary is elongate and reaches well along the second infraorbital to about the third infraorbital bone. The premaxillaries of members of the Pyrrhulinina is not well divided into upper and lower processes.

The premaxillary in members of the Lebiasinini has a single row of tricuspid teeth similar in general shape to those of the Nannostomina. The premaxillary is fairly well divided into an upper process and a lower lamella. The maxillary has a single row of peglike tricuspid teeth along its anterior edge, and its lower limb reaches to the third orbital bone.

The premaxillary in members of the Erythrininae has well-developed upper and lower limbs and a single row of conical teeth. The maxillary is well developed and in *Hoplias* the fan-shaped distal end is external to the second infraorbital. In *Erythrinus* and *Hoplerythrinus* the fan-shaped distal end of the maxillary is included under the second infraorbital. In the Erythrininae the maxillary almost reaches the third infraorbital.

Lower jaw (figs. 6, 7).—The dentary of adult specimens of the Nannostomina bears two rows of teeth; the anterior large teeth of the outer row have five or six cusps while the posteriormost few teeth may have the number of cusps reduced from one to four. The second row, composed of small conical teeth is on a crest of bone lying behind the replacement teeth of the first row. The shape of the dentary is rather remarkable and diagnostic of the Nannostomina. It is divided into two regions. The anterior region bears the teeth and is approximately like the premaxillary in shape. The posterior portion is of

the more normal characid shape and is of a thinner, lighter bone than the thick anterior region. The two regions are separated by a deep median groove and are joined by a lateroventral connecting sheet of bone. The complicated series of locking bony convolutions present at the symphysis of most characids is absent. The posterior portion of the dentary carries the tube for the laterosensory canal.

The articular lies against the medial posterior surface of the dentary and bears a socket for the articular head of the quadrate. The angular is a well-developed bone ventral and internal to the lower posterior region of the articular and dentary.

The coronomecklian (sesamoidarticular) is a prominent bone on the inside surface of the articular above the posterior region of Meckel's cartilage.

The lower jaw in the Pyrrhulinina is similar in general form and shape to that of *Brycon*. The lower jaw of males of the genus *Copella* is somewhat modified and this is correlated with the differences found in the dentition and shape of the upper jaws (Myers, 1956a, p. 12). There are two rows of conical teeth on the dentary, an outer larger row and an inner row placed on a ridge of bone behind the replacement teeth of the outer row. There is a slight notch along the lower border of the dentary just posterior to the convoluted symphysis. This notch is probably homologous with the deep ventral groove in the dentary of the Nannostomina. The rest of the bones comprising the mandible in the Pyrrhulinina are similar in their basic relationships to those of the Characinae.

In general shape the mandible in members of the Lebiasinini is like that of the Pyrrhulinina; however, the teeth in the outer row are tricuspid and similar in form to those found in the Nannostomina. The inner row is a series of very small conical teeth that, as in the subtribes Nannostomina and Pyrrhulinina, pass onto the lateral upper edge of the jaw behind the first large row of teeth.

The lower jaw in the Erythrininae is not unlike that in the Lebiasinini. In general, the placement of the dentary teeth in these two groups is much alike; however, in the Erythrininae the second row of teeth is restricted to the upper posterior edge of the dentary and to the area posterior to the first row of teeth. This second row does not advance forward on the crest of the bone behind the replacement teeth of the first and largest row of conical teeth.

MANDIBULAR AND PALATINE ARCHES (figs. 4, 6, 7).—Regan (1911, p. 21) stated that *Nannostomus* and *Characidium* belong to the family Hemiodontidae and that these two genera could be distinguished from other hemiodontids by the possession of a single series of teeth in both jaws and a broad two-headed hyomandibular. As shown above, members of the Nannostomina have two rows of teeth in the

lower jaw. Although examination shows that *Characidium* has a distinctly two-headed hyomandibular, that in the Nannostomina is single-headed. The hyomandibular in the Nannostomina is a broad bone with a broad dorsal articular surface that articulates with both the sphenotic and pterotic. It does not differ greatly in shape or relationships from the hyomandibular in the Characinae. The hyomandibular is not markedly different in shape or functional relationships in Pyrrhulinina, Lebiasinini, or Erythrininae.

The quadrate of *Nannostomus* and *Poecilobrycon* is a large, rather rectangular bone with a long, slender posterior process below the symplectic. The dorsal surface of the quadrate extends upward, lateral to the large mesopterygoid, and the dorsal profile of the quadrate is gently curved. The posterior upper surface contacts the metapterygoid and anterior end of the symplectic through cartilage. The symplectic is quite large, elongate, and rather slab-shaped posteriorly. It is almost as long as the hyomandibular. The metapterygoid posteriorly contacts the lower end of the hyomandibular through cartilage. The central circular fenestra between the quadrate, symplectic, and metapterygoid, so typical of almost all other characids, is absent in the Nannostomina. Just anterior to the upper anterior corner of the quadrate is a small triangular ectopterygoid. In some members of the Nannostomina, this bone bears a few simple conical teeth. In one species, *Poecilobrycon eques*, teeth were found on the ectopterygoid of one side but not the other in some specimens.

The toothless palatine is well developed and lies lateral to the prevomer. The anterior head of the palatine lies just posterior to the upper process of the maxillary.

The mandibular and palatine arches in the Pyrrhulinina and Lebiasinini examined are very similar to those in the Nannostomina, but, in general, these bones are not as elongate as in the Nannostomina. The ectopterygoid is toothless in the Pyrrhulinina but has conical teeth in the Lebiasini, and the bone is always proportionately larger than in the Nannostomina. The fenestra between the quadrate, symplectic, and metapterygoid is absent.

In the Erythrininae, the mandibular and palatine arches are very similar to those of the Characinae. The fenestra between the metapterygoid, quadrate, and symplectic is well developed, and the symplectic is not exceptionally deep at its posterior end. In *Hoplias* the ectopterygoid is a long, thin, tooth-bearing bone extending from the upper part of the quadrate across the inferior surface of the palatine. Anterior to its forward boundary is a small autogenous movable piece of tooth-bearing bone that is connected closely to the ectopterygoid. Sagemehl (1885, p. 95) called this bone the accessory

palatine. For reasons discussed below, I tenatively prefer to call this bone the accessory ectopterygoid. Along the lateral edge of the ectopterygoid and accessory ectopterygoid is a row of large, conical teeth. Medial to this row on both bones is a narrow patch of small, conic teeth. In *Erythrinus* and *Hoplerythrinus* the ectopterygoid extends from the quadrate to over the ventral surface of the palatine (autopalatine). The ectopterygoid in both bears a band of conic teeth. In *Hoplerythrinus*, but not in *Erythrinus*, small conic teeth are present on the ventral surface of the mesopterygoid. In a specimen of *Hoplerythrinus unitaeniatus*, 115 mm. in standard length, from British Guiana, CAS(IUM) 12331, the mesopterygoid teeth are well developed and cover much of that bone's lower surface; however, a specimen from Peru, SU 35044, which is 120 mm. in standard length, has only a few scattered teeth over the mesopterygoid.

Hoedeman (1950b) described a new genus and species in the Erythrininae, *Pseuderythrinus rosapinnis*, from Dutch Guiana. His new genus seems distinguishable from *Hoplerythrinus* only by the number and distribution of teeth on the palatal arch. He recorded a narrow band of teeth on the palatines and no teeth on the "pterygoid" for *Pseuderythrinus*, and he stated that *Hoplerythrinus* has a broad patch of teeth on the palatine and that there are teeth on the pterygoid. Hoedeman's pterygoid is the ectopterygoid of the present account. Examination of a cleared and alizarin-stained specimen and other, nonstained specimens of *Hoplerythrinus* does not confirm Hoedeman's views concerning the placement of teeth in this genus. I find that *Hoplerythrinus* has teeth on the ectopterygoid, no teeth on the palatine, and it may have a broad patch of teeth on the mesopterygoid. The mesopterygoid teeth may be numerous or few and they are usually fewer in small specimens. It seems likely that the specimen, 128 mm. in standard length, forming the basis of Hoedeman's new genus, has as yet failed to develop a dense aggregation of mesopterygoid teeth, and it seems likely that this genus is a synonym of *Hoplerythrinus*. The color and other characters of *Pseuderythrinus rosapinnis* are very much like those of *Hoplerythrinus unitaeniatus;* further investigations probably would indicate that, at most, *P. rosapinnis* is a subspecies of *H. unitaeniatus*. The type of *Pseuderythrinus rosapinnis* needs reexamination.

Hoedeman (1950b, p. 85) recorded palatine teeth present in *Hoplias*, *Hoplerythrinus*, and *Erythrinus* and stated that there are no teeth on the "pterygoid" in *Erythrinus*. This disagrees with what I found in the specimens at hand.

No specimens of these genera were found to have palatine teeth attached to the palatine. This fact is difficult to determine and requires considerable and careful dissection, especially in *Erythrinus*

and *Hoplerythrinus*. In these two genera the tooth-bearing ecopterygoid (= the pterygoid of Hoedeman) is firmly attached to, but not fused with, the palatine. The anterior part of the ectopterygoid lies ventral to the palatine in these two genera and can be mistaken easily for palatine dental plates or dermopalatines. The autogenous tooth-bearing bone below the palatine in *Hoplias* has been described above.

Determination of the homologies of the tooth-bearing elements associated with the autopalatine of the Erythrininae cannot be stated precisely from the examination of adult stages only. The interpretation tentatively adopted here for the morphological situation in *Hoplerythrinus* is based on the following: The ectopterygoid is present and often tooth-bearing in other characids. It is presumed here that the ectopterygoid bone grows anteriorly under the lower surface of the palatines and that the dermal tooth-bearing bones under the autopalatine are not dermopalatine elements that have fused to the ectopterygoid but are simply anterior extensions of the ectopterygoid. The striations and growth pattern of these tooth-bearing bones indicate they are anterior extensions of the ectopterygoid.

The accessory palatine of Sagemehl (1885, p. 95) that occurs in *Hoplias* may be interpreted in two ways, either as a dermopalatine or dental element that has not fused to the ectopterygoid or as an autogenous, anterior piece of the ectopterygoid. Starks (1926, p. 161) maintains that the accessory palatine is homologous with the dermopalatine of *Amia*. This problem cannot be resolved with the information at hand.

Probably the presence of teeth or dental plates associated with the palatine, ectopterygoid, and mesopterygoid is a conservative feature not retained in most other characids; in this respect the tooth pattern of the Erythrininae would be more primitive than that of the other subfamilies of living characids. If this is correct, the separation of the Erythrininae from the rest of the characids might be suspected then to have taken place when the characids had living representatives much more primitive than those extant. In this connection, the morphology and development of the first infraorbital and its relationship to the antorbital in the Erythrininae and possible significance of the infraorbital in the phylogeny of characids and Ostariophysi should be investigated.

Hyoid and branchial arches (fig. 8).—The hyoid arch of *Nannostomus* and *Poecilobrycon* is not unlike that of the Characinae, and the relative positions of the bones of the arches are the same. There are two branchiostegal rays associated with the ceratohyal and one with the epihyal. Members of the tribe Pyrrhulinini also have three branchiostegal rays, while members of the tribe Lebiasinini have four

branchiostegal rays, three associated with the ceratohyal and one with the epihyal. All members of the Erythrininae have five branchiostegal rays, four on the ceratohyal and one on the epihyal.

The branchial arches of the Erythrininae and Lebiasininae are like those of the Characinae and differ mainly in general proportions correlated with different head shape.

Hoedeman (1950a, pp. 17, 19, 25) stated that pharyngeal teeth are absent in three species of his Nannostominae. All specimens of the Nannostomina, however, that I have examined have small, conic pharyngeal teeth much like those illustrated for *Poecilobrycon harrisoni* (fig. 8). The gill rakers of members of the Lebiasininae are simple; however, in the Erythrininae the gill rakers are rather complex. The bony cores of those of the upper limb are truncate with small conical "teeth" along their distal margins while those of the lower limb are serially graduated from truncate ones anteriorly to elongate sharp-pointed laminae of bone posteriorly. The dorsal edges of these laminae bear small conic "teeth" while the anterior truncated gill rakers have "teeth" along their distal borders.

WEBERIAN APPARATUS (fig. 9).—The Weberian apparatus of the Lebiasininae and Erythrininae is, in all major respects, like that of the genus *Brycon* and the Characinae, differing only in a few aspects of shape and in the proportions of some of the parts. The tripus of *Poecilobrycon harrisoni* is slightly different in shape from that of *Brycon meeki* but still retains the basic characid structure. Its dorsal proximal portion is placed slightly higher and more anterior on the body of the third vertebra. In some specimens of the Nannostomina examined there are small contingencies of bone across the joint between the neural pedicel and the neural complex.

PECTORAL GIRDLE (fig. 10).—The pectoral girdle of *Poecilobrycon harrisoni* is much like that of the Characinae, having a large medial coracoid lamina. The main body of the cleithrum, like that of the Characinae, is a sickle-shaped lamella; however, the large foramen between the coracoid and the cleithrum, so typical of the Characinae, is absent or at best only a slight opening. The supracleithrum lacks a sensory canal in all members of the Nannostomina and the post-temporal is not forked, the lower spinous process found in the Characinae being absent. The relationships of the postcleithrum, mesocoracoid, and scapula are not markedly different from those of the Characinae.

In the Pyrrhulinina, sensory canals are lacking in the post-temporal and supracleithrum, and the post-temporal is not forked. The rest of the pectoral girdle is typical of that of characids. Unlike the Nannostomina, the Pyrrhulinina have a large foramen between the coracoid and the cleithrum. In speicmens of *Lebiasina* and *Pia-*

bucina, the foramen between the coracoid and cleithrum is well developed. The rest of the pectoral skeleton in these two genera is like that of the Characinae.

The pectoral girdle of the Erythrininae is unique among characids. The lower limb of the cleithrum is long and slender. The lateral inferior lamella is much reduced in extent. The median coracoid lamella is extremely reduced in size, being a very narrow crest or actually absent. In all other characids that I have examined, the coracoid extends anteriorly to, or almost to, the anterior edge of the cleithrum. In the Erythrininae, the coracoid extends anteriorly for only about one-half the length of the lower limb of the cleithrum, and the foramen between the cleithrum and coracoid is absent. The cleithrum and post-temporal of the Erythrininae contain segments of the laterosensory canals.

Classification of the Characid Subfamilies Lebiasininae and Erythrininae

The following classification is based primarily on the evidence presented in the foregoing section.

SUBFAMILY LEBIASININAE EIGENMANN, 1910

Definition: (1) Large fenestra between quadrate and metapterygoid absent. (2) Two diverging lamellae on ventral surface of ethmoid very poorly developed. (3) Lateral posterior edge of frontal not articulated with spinous process of sphenotic. (4) Six infraorbital bones present; antorbital and first infraorbital separate ossifications. (5) Accessory ectopterygoid (or dermopalatine?) absent. (6) Lower limb of cleithrum moderately stout, not long and slender, its lateral inferior lamella large. (7) Coracoid lamella a large flat plate, reaching to near anterior border of cleithrum. (8) Anastomosis between supraorbital and dermopterotic canal present. (9) Parietal and epiphyseal branches of supraorbital canal reduced in length, parietal branch never reaching parietal bone. (10) Perforated lateral line scales, when present, confined to region anterior to dorsal fin. (11) Frontal fontanel always absent in adults. (12) Teeth well developed in both jaws, unicuspid or multicuspid. (13) Premaxillary with one tooth row. (14) Dentary usually with two rows of teeth. (15) Gape short, not reaching orbit, or, at most, only reaching posteriorly little beyond verticle with anterior margin of orbit. (16) Branchiostegal rays three or four. (17) Gill membranes partially united but free from isthmus. (18) Body elongate, often fusiform or with fairly blunt head; body rounded in cross section in region of dorsal fin and head, compressed in region of caudal peduncle. (19) Adipose fin

present or absent. (20) Anal fin short-based, with 8 to 14 rays. Males often with specialized anal fin rays; these expanded in anterior-posterior plane and often thickened laterally. (21) Dorsal fin always in advance of anal fin, placed over pelvic fins. (22) Caudal fin rounded or forked. (23) Scales large, 6 to 7 horizontal rows between dorsal and pelvic fines, 18 to 30 scales in longitudinal series.

The tribes of subfamily Lebiasininae are:

Lebiasinini Eigenmann, 1910
Pyrrhulinini Eigenmann, 1910

TRIBE LEBIASININI EIGENMANN, 1910

Nomenclatural note: Eigenmann (1910) was the first to base a family group name, Lebiasininae, on the genus *Lebiasina*. Hoedeman (1950b) was the first to propose the use of this family group name as a tribe.

Definition: (1) Four branchiostegal rays. (2) Premaxillary divided into well-developed upper and lower rami. (3) Premaxillary teeth tricuspid, in one row. (4) Dentary with teeth in two rows, outer row teeth tricuspid, inner with simple, conic teeth. (5) Dentary without inferior deep notch or groove, ventral surface smooth. (6) Parietal branch of supraorbital sensory canal moderately well developed, reaching almost to parietal bone. (7) Supratemporal laterosensory canals present. (8) Dermopterotic laterosensory canals present. (9) Extrascapular laterosensory canals and bones present. (10) Supracleithrum with laterosensory canal. (11) Frontalpterotic joint present on surface of skull.

The genera of tribe Lebiasinini are:

Lebiasina Valenciennes (1846), with two species.
Piabucina Valenciennes (1849), with six or seven species.

Remarks: *Lebiasina* has been separated from *Piabucina* by the absence of an adipose fin in the former and its presence in the latter. This is apparently a poor character in these fishes, for, as Eigenmann (1923, p. 123) noted, some specimens of *Lebiasina bimaculata* and *Lebiasina multimaculata* occasionally have an adipose fin. In the specimens I have been able to examine, the anterior wall of the posterior division of the swimbladder in *Lebiasina bimaculata* and *Piabucina festae* is "cellular" while in *Piabucina erythrinoides* and *Piabucina panamensis* it is not. The tribe Lebiasinini needs revision at the specific and generic level.

TRIBE PYRRHULININI EIGENMANN, 1910

Nomenclatural note: Eigenmann (1910) was the first to base a family group name, Pyrrhulininae, on the genus *Pyrrhulina*. Hoedeman (1954a) was the first to propose the use of this family group name as a tribe Pyrrhulinini.

Definition: (1) Three branchiostegal rays. (2) Premaxillary only weakly, or not at all, divided into upper and lower processes. (3) Premaxillary teeth simple conic to hexacuspid, in one or two rows. (4) Dentary with teeth in two rows, uni- to hexacuspid. (5) Dentary with inferior notch below or deep groove continuous with foramen for mental ramus of mandibular branch of trigeminal nerve. (6) Parietal and epiphyseal branches of supraorbital laterosensory canal extremely short, usually not over one or, rarely, two millimeters long even in largest specimens of largest species; parietal canal not reaching parietal bone. (7) Supratemporal laterosensory canal absent. (8) Dermopterotic canal absent. (9) Extrascapular laterosensory canals and bones absent. (10) Supracleithrum without enclosed laterosensory canal. (11) Frontal-pterotic joint absent, pterotic being excluded from contact with frontal by sphenotic.

The subtribes of tribe Pyrrhulinini are:

Pyrrhulinina
Nannostomina

SUBTRIBE PYRRHULININA EIGENMANN, 1910

Definition: (1) Premaxillary-ethmoid articulation a very slightly movable, syndesmotic (fibrous) joint. (2) In adults, posterior shaft of prevomer reaches parasphenoid. (3) Preopercle extends anteriorly to near articular. (4) Maxillary bone extends posteriorly to region of second orbital. (5) Premaxillary with unicuspid teeth. (6) Teeth of dentary unicuspid, in two rows. (7) Dentary not divided into two well-defined regions by a deep ventral groove continuous with mental foramen. Dentary with notch below region of mental foramen. (8) Inferior portion of post-temporal fossa extremely large, its anterolateral border extending anterior to, or beyond, synchondral portion of joint between sphenotic and pterotic bones, anteriorly beyond vertical from anterior edge of auditory foramen.

The genera of subtribe Pyrrhulinina are:

Pyrrhulina Valenciennes (1846), with perhaps a dozen species
Copeina Fowler (1906), with two or three species
Copella Myers (1956a), with four or five species

SUBTRIBE NANNOSTOMINA EIGENMANN, 1909

Nomenclatural note: Eigenmann (1909a) was the first to base a family group name, Nannostomatinae, on the genus *Nannostomus*. The proper spelling of this family group name should have been Nannostominae (Miller, 1897, p. 132).

Definition: (1) Premaxillary-ethmoid articulation a loose movable syndesmotic (fibrous) joint connected by fairly long, interosseous ligaments, but premaxillary not protractile, synovial joint absent.

(2) Posterior shaft of prevomer reduced or absent in adults and young, never reaching parasphenoid. (3) Preopercle not reaching near articular, extending anteriorly only to lower posterior process of quadrate. (4) Maxillary confined to anterior region of first infraorbital bone. (5) Premaxillary teeth 1- to 6-cusped, usually 3- to 6-cusped, multicuspid teeth flattened and incisor-like. (6) Dentary with outer row of flattened, 3- to 6-cusped incisor-like teeth and one inner row of unicuspid conic teeth. (7) Dentary divided into two distinct regions by a deep inferior groove continuous with the mental foramen. (8) Lower portion of post-temporal fossa not enlarged, its anterolateral border well posterior to vertical from synchondral joint between sphenotic and pterotic, anterolateral border of post-temporal fossa behind vertical from anterior edge of auditory foramen.

The genera of subtribe nannostomina are:

Nannostomus Günther (1872), with five or six valid species
Poecilobrycon Eigenmann (1909b), with three valid species

Note that *Nannobrycon* of Hoedeman (1950a) is here considered a subgenus of *Poecilobrycon* and *Archicheir* Eigenmann (1909b) is considered a synonym of *Poecilobrycon*. *Archicheir minutus* Eigenmann (1909b), the type of *Archicheir*, is based on the young of *Poecilobrycon harrisoni* Eigenmann (1909b). A review of the genera and species of the Nannostomina is in preparation.

SUBFAMILY ERYTHRININAE GILL, 1858

Definition: (1) Large fenestra between quadrate and metapterygoid present. (2) Two diverging lamellae on ventral surface of ethmoid well developed. (3) Lateral posterior edge of frontal articulated with spinous process of sphenotic. (4) Six infraorbital bones present; first infraorbital apparently fused with antorbital. (5) Accessory ectopterygoid (or dermopalatine) present, ventral to autopalatine either as an autogenous element or fused with ectopterygoid. (6) Lower limb of cleithrum long and slender, its lateral inferior lamella small. (7) Coracoid lamella small or absent, not large, flat plate as in other characids, not reaching to near anterior border of cleithrum. (8) Anastomosis between supraorbital and dermopterotic laterosensory canal absent. (9) Parietal and epiphyseal branches of supraorbital canals well developed, parietal canal reaching parietal bone. (10) Perforated lateral line scales present, continued uninterrupted to caudal fin. (11) Frontal fontanel always absent in adults. (12) Teeth well developed, unicuspid, conic in both jaws. (13) Premaxillary with one tooth row. (14) Dentary with anterior tooth row bordering length of jaw, inner tooth row confined to posterior portion of mandibular ramus. (15) Gape long, reaching

posteriorly beyond vertical from anterior border of orbit. (16) Branchiostegal rays five. (17) Gill membranes partially united but free from isthmus. (18) Body elongate, with blunt head and snout; body rounded in cross section in region of dorsal fin and head, compressed in region of caudal peduncle. (19) Adipose fin absent. (20) Anal fin short-based, with about 10 to 12 rays. (21) Dorsal fin always in advance of anal fin, usually over pelvic fins. (22) Caudal fin rounded in profile. (23) Scales moderate to fairly large, about 30 to 45 in a lateral series, about 7 to 12 in horizontal rows between dorsal and pelvic fins.

The genera of subfamily Erythrininae are:

Hoplias Gill (1903), with one or two species
Erythrinus Scopoli (1771), with one species
Hoplerythrinus Gill (1895), with one species
Pseuderythrinus Hoedeman (1950b), with one species, status uncertain

Remarks: Of the characters listed above, 3–8 seem to be diagnostic for the subfamily, distinguishing its members from all other characids.

Relationships of the Subtribe Nannostomina and its Close Relatives, the Pyrrhulinina

The classification above clearly indicates the close relationship of the Nannostomina and Pyrrhulinina. The unique structure of the dentary in these two groups, together with the accumulation of such characters as three branchiostegal rays, a premaxillary without a clear upper or lower process, short parietal and epiphyseal laterosensory canals, no supratemporal or dermopterotic canals, no extrascapular bone or canal, no canal embedded in the supracleithrum, and the lack of a frontal-pterotic joint, cannot be due to convergent evolution but only to a common ancestry. Further inspection of these fishes reveals other similarities; for example, their scales are almost identical in shape and structure, both groups have members with modified anal fin rays in the males, both have a tendency to lose canals in orbital bones, and one species, *Nannostomus espei*, has a color pattern remarkably like that of *Pyrrhulina vittata* and *Pyrrhulina spilota*. *Nannostomus espei* also has scales that more closely approach the shape of those of *Pyrrhulina* than the scales of any other species in the Nannostomina. The osteology of *Nannostomus espei*, however, is typically that of *Nannostomus*.

The Nannostomina are specialized for feeding on small animal organisms that occur on plants, rocks, and other objects. They also feed on slowly moving free-living organisms. Their movements are relatively slow and precise. The Pyrrhulinina are more active and more predaceous, having larger mouths, attacking larger prey, and

striking their prey harder. The jaws of the Nannostomina are far more specialized than those of the Pyrrhulinina. The large post-temporal fossa in the Pyrrhulinina is an interesting specialization. The large amount of muscle tissue found in this area undoubtedly is associated functionally with feeding and swimming behavior, but this needs further study.

In addition to the differences between the Pyrrhulinina and Nannostomina noted in the classification above, these two groups have a consistent difference in body shape. The body form in the Nannostomina usually is smoothly fusiform, whereas that in the Pyrrhulinina is not, the profile showing a slight notch behind the dorsal fin, the belly being more or less flat, and the back being less arched. Of all the species in the Nannostomina, *Nannostomus espei* has a body shape closest to that of the Pyrrhulinina.

Despite the differences between the Pyrrhulinina and the Nannostomina, I believe they may be united justifiably in the tribe Pyrrhulinini, based on the morphological characters listed above.

The relationships of the Pyrrhulinini are, without doubt, with the Lebiasinini, and these two tribes form the subfamily Lebiasininae. The characters listed in the classification for this subfamily (p. 148) are held in combination by no other characids. A full discussion of the relationships between the Lebiasinini and the Pyrrhulinini should await fuller treatment of the genera in these two tribes.

From the information at hand it seems safe to conclude that the Pyrrhulinini were derived from characids somewhat similar perhaps to the existing members of the Lebiasinini and that the Pyrrhulinina and the Nannostomina had a common ancestor. Neither of these two subtribes can be derived from the other, but their common ancestor must have differed from the recent members of the Lebiasinini in the structure of the jaws and reduction of the laterosensory system of the head.

Relationships of the Lebiasininae and Erythrininae

What are the relationships of the Lebiasininae and Erythrininae that can be determined from the present osteological study? Considering the absolute lack of fossil evidence in this case, inferences about phylogenetic relationships based on recent material are bound to bear only a vague resemblance to the actual course of evolution; nevertheless, an attempt should be made to indicate relationships even if this involves nothing more than noting that certain groups appear associated because they have a certain number of characters in common.

The relationships of the Erythrininae to other recent characids remain rather obscure. They are not close to the Characinae and they do not appear derived from them. A consideration of the primitive versus specialized aspects of their skeleton may give some hint regarding their relationships. In general, a reduction in number of branchiostegal rays in teleosts can be considered a specialized feature (Hubbs, 1919). In all probability, the presence of five branchiostegal rays in the Erythrininae is relatively primitive for characids. The absence of the supraorbital in both the Erythrininae and the Lebiasininae probably is specialized and I suspect that this is also true for the morphology of the antorbital in the Erythrininae. Dental plates and teeth associated with the palatine, ectopterygoid, and mesopterygoid in the Erythrininae is probably a primitive feature in these fishes. The unique absence of a connection between the dermopterotic and supraorbital laterosensory canals in the Erythrininae probably is specialized. Whether the articulation between the sphenotic and frontal in the Erythrininae is primitive or specialized cannot be said. It would seem that the pectoral girdle of the Erythrininae is rather specialized because the interosseus space, usually present in teleosts and other subfamilies of characids (Starks, 1930, p. 90), is absent; however, the gross morphology of the pectoral girdle of the Erythrininae is in some respects similar to that of *Amia* and it is possible that the form of the pectoral girdle in the Erythrininae is rather primitive. Likewise, it is difficult to evaluate the generalized (versus specialized) nature of other characters of the Erythrininae. The short-based anal fin is probably primitive with regard to the Characidae and Cypriniformes as a whole, and the same may be true of the large scales. It is also possible that the rather blunt, cylindrical body shape is primitive.

Examination of the osteology of *Hepsetus* indicates certain relationships with *Erythrinus* and *Hoplias*. Bertmar (1959, p. 350; and in litt.) has noted that *Hepsetus* is more primitive from the embryological point of view than the other ten characids he examined and that all the characids he investigated are more primitive in certain respects than *Amia*. This of course does not mean that characids are more primitive than *Amia*, but it does pose questions about the origins of the Cypriniformes. The Erythrininae appear to be more primitive osteologically than *Hepsetus*. Investigation of the ontogeny of their chondrocranium should be very fruitful.

About all that can be concluded here is: (1) the Erythrininae are definitely characid in morphology; (2) but their basic structure is more remote from that of the so-called "central group of characids" (i.e., the Characinae) than of any other known living characid; (3) they probably were not derived from a characid ancestor that was

like any living member or members of the Characinae. There is perhaps more reason to give separate family status to the Erythrininae than to any other subfamily of characids. Also there is some reason to suspect that at least in certain features, the Erythrininae are the most archaic of living characids. In other aspects, however, they are possibly quite specialized.

What are the relationships of the subfamily Lebiasininae? Superficially, members of the tribe Lebiasinini look much like members of the Erythrininae because of their large scales, short-based anal fin, and the overall similar appearance of the body and head. In addition, both groups lack the supraorbital. The last is possibly not too important a character, for loss of an element probably never should be considered as important as the development of a new structure. Except for the fact, however, that these two groups are characids and have similarly shaped cranial bones because of their similar general body and head shape, they have little in common osteologically. In all the unique respects in which the Erythrininae differ from the Characinae, the Lebiasininae are like the Characinae. As noted above, members of the tribe Lebiasinini and indeed the entire Labiasininae have a few very unique characters that are different from those of both the Characinae and the Erythrininae. The unique lack of a fenestra between the quadrate and metapterygoid appears specialized. Also, the general reduction in the laterosensory canals of the head of the Lebiasininae and the unique laterosensory head canals of the member subtribes of the Pyrrhulinini are very specialized. It seems likely (1) that the Lebiasininae are somewhat more closely related to the Characinae than to the Erythrininae and (2) that the Lebiasininae evolved from a common characid stock that gave rise to Lebiasininae and Characinae but not to the Erythrininae.

According to several authors, one of the distinguishing characters of the Lebiasinini is the possession of a "cellular" anterior wall of the posterior chamber of the swimbladder. The present investigation indicates that certain species (*Piabucina panamensis* and *P. erythrinoides*) in this group lack this feature while others (*Lebiasinina bimaculata* and *Piabucina festae*) do have it. Obviously, the group needs revision and, since Böhlke (1958, p. 94) has indicated he is doing this, no revision is attempted here. It should also be noted that, of the Erythrininae, at least *Hoplerythrinus unitaeniatus* and *Erythrinus erythrinus* have a cellular anterior wall of the posterior chamber of the swimbladder. *Hoplias malabaricus* does not. The significance of the similar "cellular" structure of swimbladders of some members of the Erythrininae to that of some of the Lebiasinini is difficult to assess. In view of the distinct osteological differences between the Erythrininae and the Lebiasinini, however, I prefer to believe that

this equivalence of structure is due to similar adaptation to stagnant water and that it does not indicate close genetic relationships. Osteological comparisons indicate that the Lebiasininae are not related closely to such genera as *Anostomus*, *Leparinus*, and *Hemiodus*.

Summary

The primary results of this study are as follows: The Lebiasininae and Erythrininae are defined and their relationships to each other and to other characids are discussed. The Lebiasininae are not related closely to the Erythrininae as assumed by many earlier authors. The Erythrininae cannot have been derived directly from ancestors that were like recent members of the Characinae (as defined by Weitzman, 1962, p. 48). Although the evidence is inconclusive, of all living characids, the Erythrininae are probably the most conservative (in some ways). It is surmised that the Characinae and Erythrininae were derived from a common characid stock remote in time and morphology from these two subfamilies as they are known today. The Lebiasininae, in many important respects, are more closely allied morphologically to the Characinae than to the Erythrininae despite their superficial resemblance to the Erythrininae. It appears that the Lebiasininae may have been derived from early members of the Characinae or at least from ancestral characids that were more like the Characinae than the Erythrininae in their morphology.

The subfamily Lebiasininae consists of two tribes, the Lebiasinini and the Pyrrhulinini. Both are defined herein. The Lebiasinini needs revision, but no attempt was made to reevaluate in this study its genera and species. The Pyrrhulini consists of two subtribes, the Pyrrhulinina and the Nannostomina, and both are defined herein.

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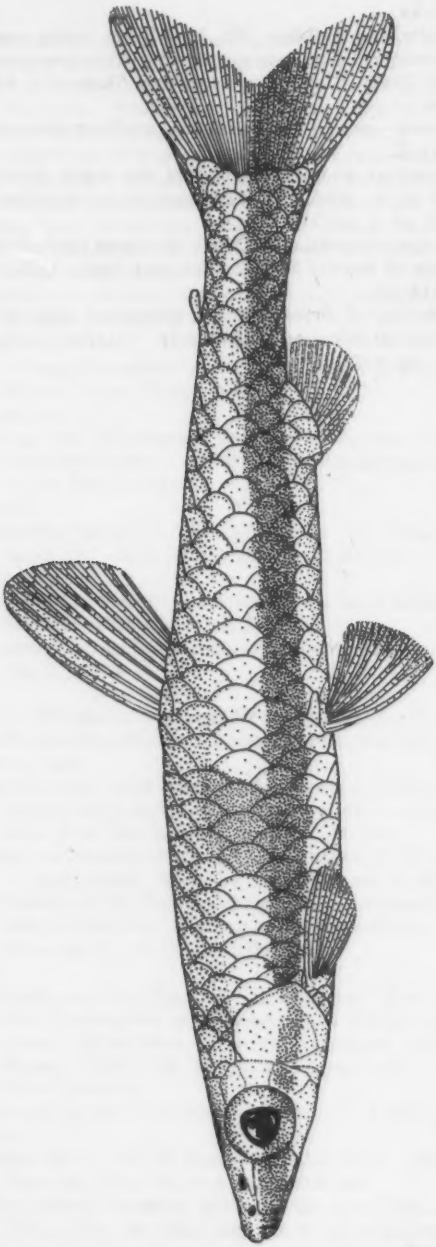


FIGURE 1.—Lateral view of a male *Poecilobrycon harrisoni* Eigenmann, SU 50243, 38.5 mm. in standard length. Georgetown, British Guiana.

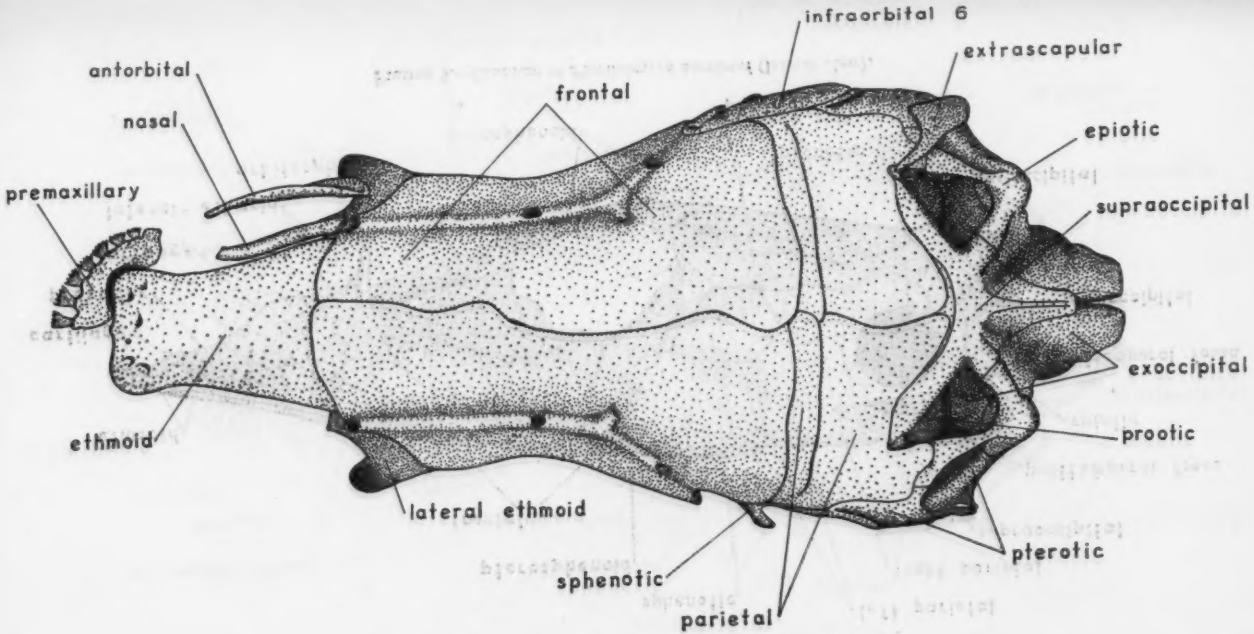


FIGURE 2.—Cranium of *Poecilobrycon harrisoni* (dorsal view).

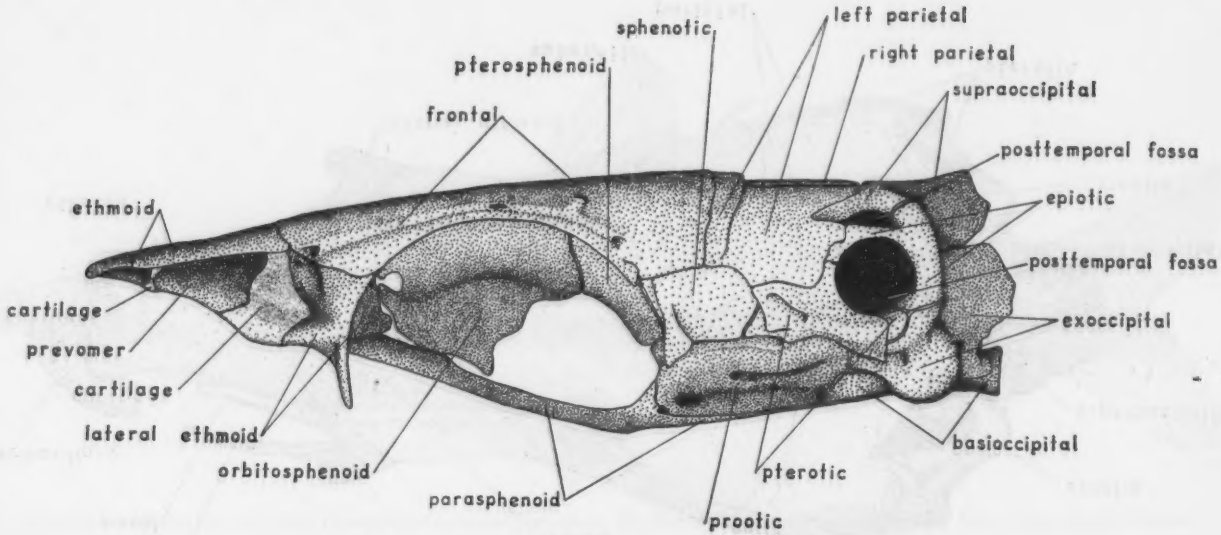


FIGURE 3.—Cranium of *Poecilobrycon harrisoni* (lateral view).

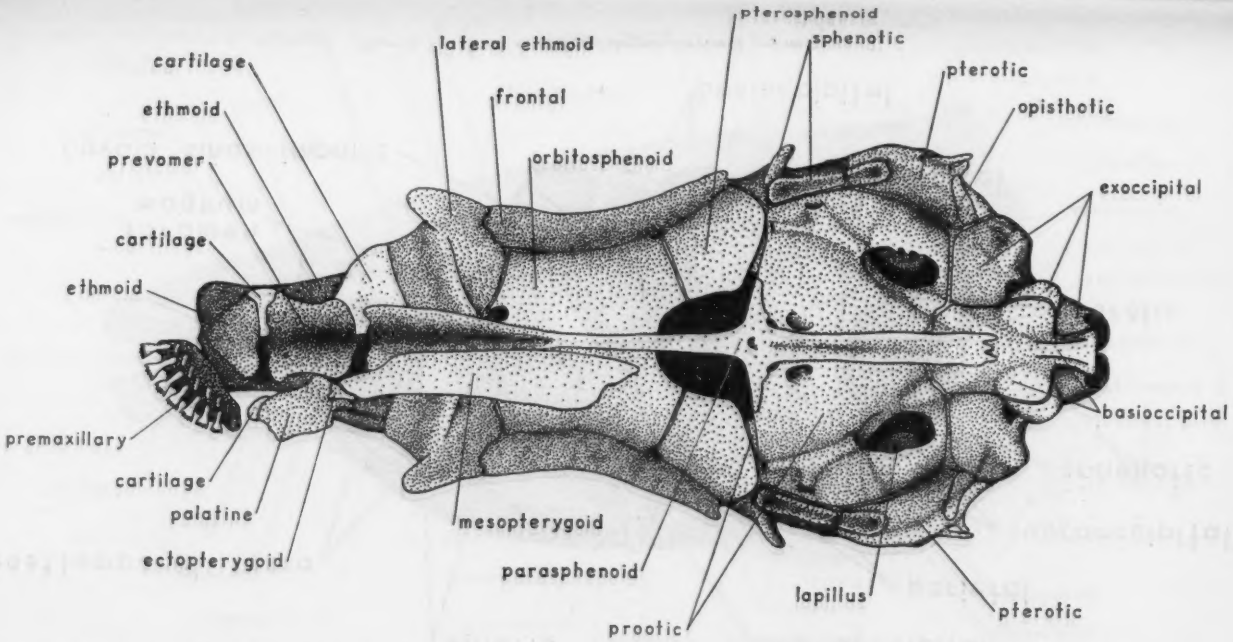


FIGURE 4.—Cranium of *Poecilobrycon harrisoni;* also illustrated are the right premaxillary and the right platine arch (ventral view). The cartilage between the ethmoid, prevomer, and lateral ethmoid is shown on the left side only.

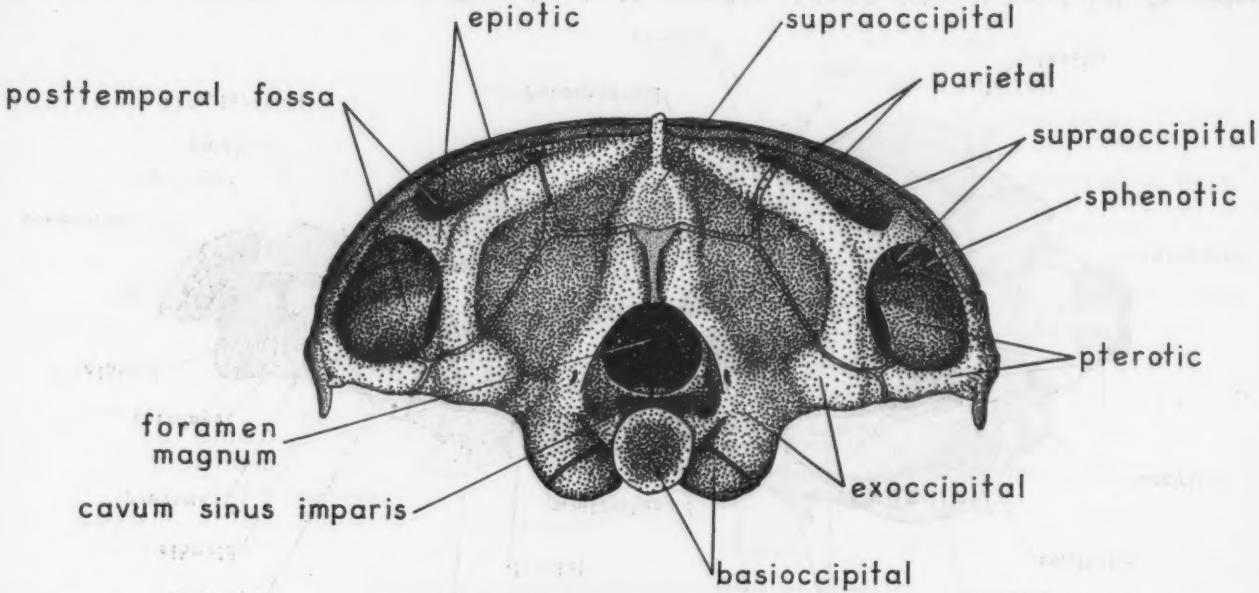
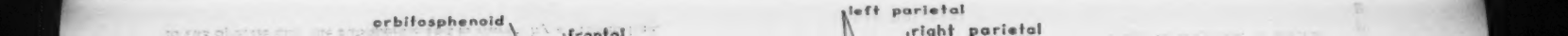


FIGURE 5.—Cranium of *Poecilobrycon harrisoni* (posterior view).



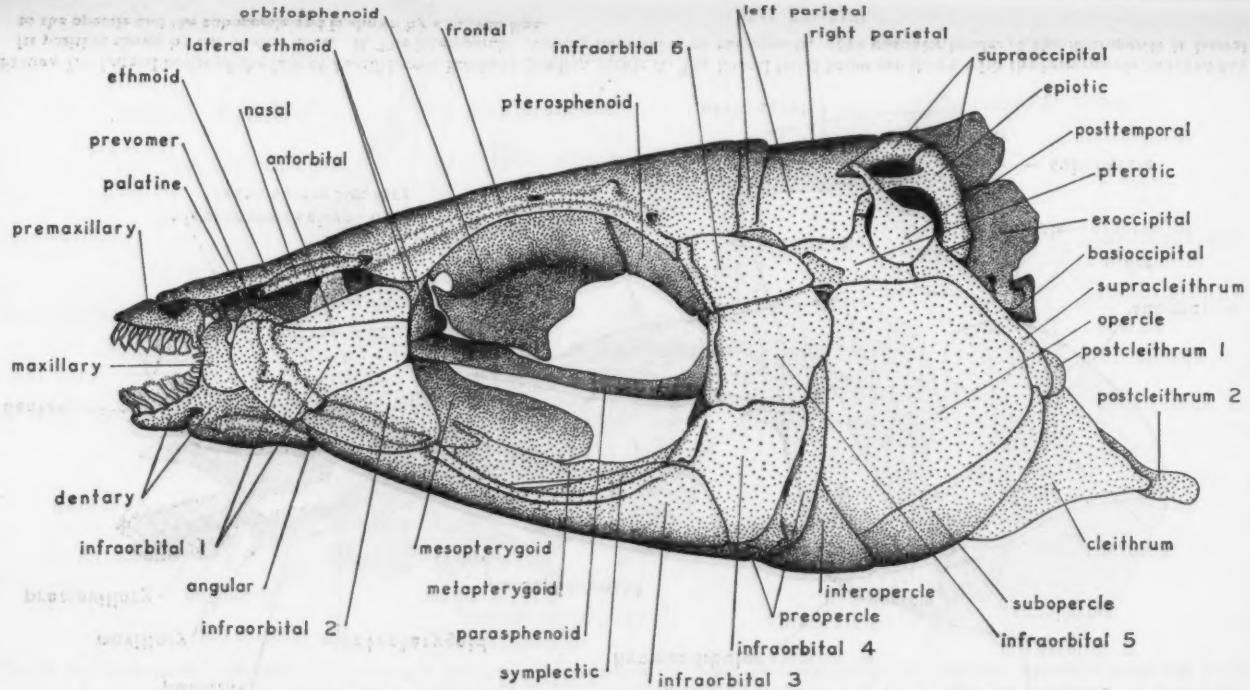


FIGURE 6.—Skull of *Poecilobrycon harrisoni*, including part of the pectoral girdle (lateral view).

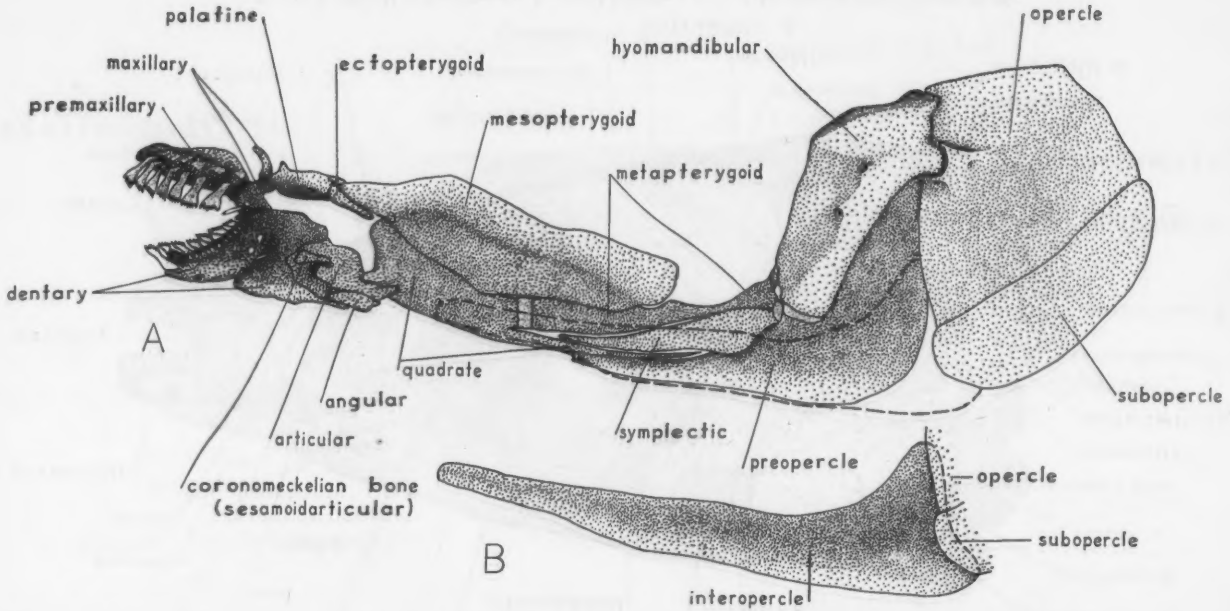
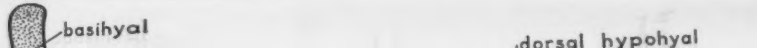


FIGURE 7.—Lateral bones of the face of *Poecilobrycon harrisoni* (median view): A, The lateral facial bones are shown with the interopercle removed but its position shown by the broken lines. B, The interopercle, showing its relation to the opercle. The posterior border of the interopercle is lateral to the opercle and the subopercle and is shown by a broken line.



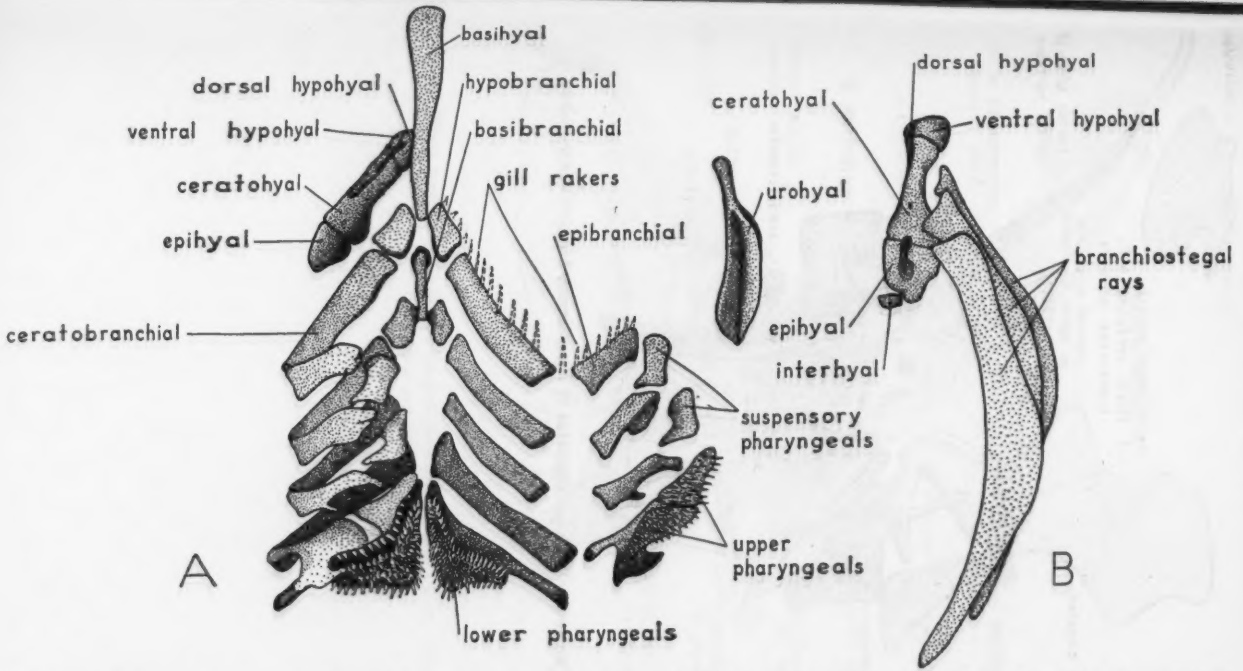


FIGURE 8.—Hyobranchial apparatus of *Poecilobrycon harrisoni:* A, Hyoid arch (left side), branchial arches, and urohyal. Branchial arches and hyoid arch in dorsal view except upper element of right side in ventral view. Urohyal in right lateral view. B, Hyoid arch and branchiostegals (right side, lateral view).

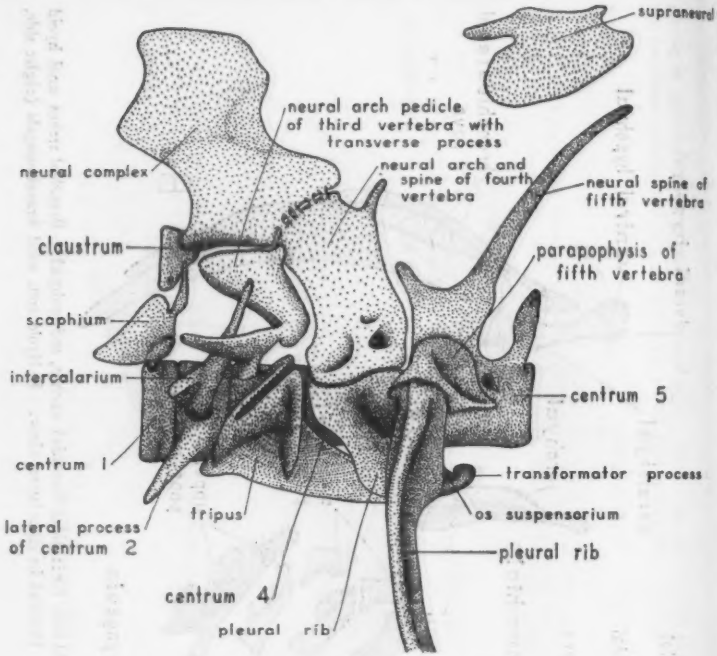


FIGURE 9.—Weberian apparatus of *Poecilobrycon harrisoni* (lateral view).

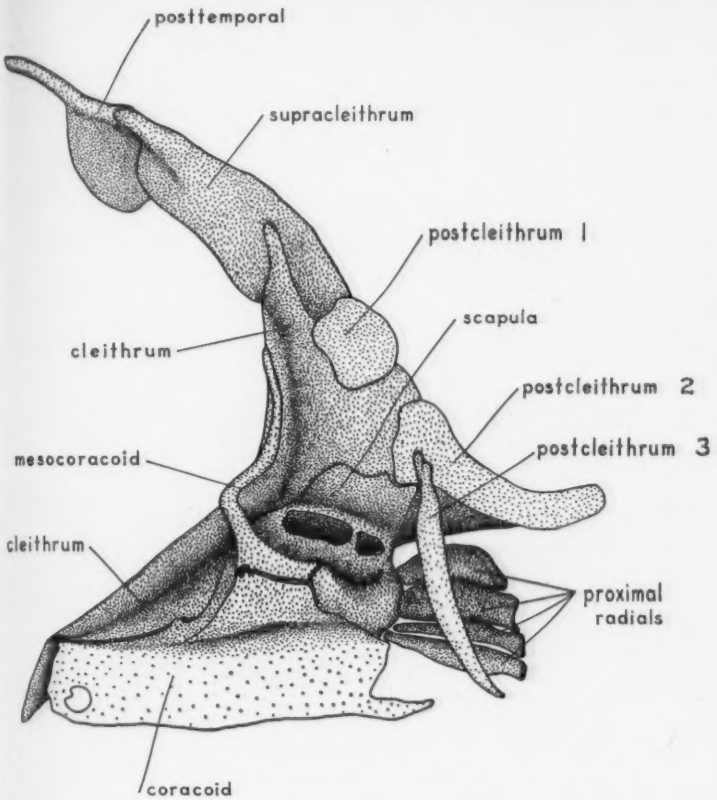


FIGURE 10.—Right pectoral girdle of *Poecilobrycon harrisoni* (median view). The fin rays have been removed.

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THREE NEW SPECIES OF FROGFISHES FROM THE INDIAN AND PACIFIC OCEANS WITH NOTES ON OTHER SPECIES (FAMILY ANTENNARIIDAE)

By LEONARD P. SCHULTZ

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THREE NEW SPECIES OF FROGFISHES FROM THE INDIAN AND PACIFIC OCEANS WITH NOTES ON OTHER SPECIES (FAMILY ANTENNARIIDAE)

By Leonard P. Schultz

The purposes of this paper are: (1) to evaluate further certain diagnostic characters of frogfishes; (2) to call attention to nomenclatural changes; (3) to describe three new species; (4) to record specimens and data not available at the time I reviewed the family Antennariidae (Proc. U.S. Nat. Mus., vol. 107, no. 3383, pp. 47–105, 8 figs., 14 pls., 1957).

I am grateful to the staffs of the California Academy of Sciences (CAS), San Francisco, California; of the University of Hawaii (UH), Honolulu, Hawaii; and of the Division of Systematic Biology, Stanford University (SU), for permitting me to study the specimens in their collections. The following abbreviations, refer to other specimens recorded in this paper: RMNH (Rijikmuseum van Natuurlijke Historie, Leiden) and USNM (United States National Museum).

729-309—64

Diagnostic Characters

The study of additional material, not available previously, has enabled me to reconsider certain unsolved problems as well as to investigate new ones. My description of the bait as a "non-filamentous simple slender tentacle" has led to misinterpretation. This type of bait is considered to be a simple or unbranched central stalk, varying from a single slender threadlike tentacle to one that is somewhat fleshy, as contrasted to a tuft of tentacles or a bulbous base with tentacles. In addition, it should be understood that the bait is extensible and, when contracted, may be fleshy in nature; yet it retains the single central stalk.

Further attention has been given to the evaluation of the presence or absence of warts on the skin of frogfishes as a taxonomic character. Two species with warts were described by Bleeker, *Antennarius phymatodes* and *A. oligospilos*. During my examination of specimens of *A. moluccensis* Bleeker in the collection of the University of Hawaii, I encountered an abnormal specimen with "warts"—UH 403, collected at Diamond Head, Oahu, measuring 87 mm. from tip of snout to base of caudal fin. Dr. Victor G. Springer informed me that he investigated "warts" on a large frogfish collected in the Gulf of Mexico and that the warts were encysted nematodes. Thus, "warts" on the skin of frogfishes may be of questionable value in distinguishing species.

Briggs (Copeia, vol. 2, p. 440, 1962) distinguished *Antennatus reticularis* from *A. strigatus* on supposed differences in the length of the ilicium in relation to the length of the second dorsal spine and on the characteristic that the esca is blunt and lobed instead of lanceolate.

Rosenblatt (Copeia, vol. 2, pp. 462–464, 1963) investigated this problem by measuring the length of the ilicium and the second dorsal spine on 62 specimens, then analyzing his data statistically. He concluded that "only one population was represented in the sample." He compared the pectoral ray counts of *A. strigatus* and *A. bigibbus* and concluded that the eastern Pacific population of *A. strigatus* was distinct from the western Pacific population of *A. bigibbus*. This leaves the two species as valid and in agreement with the conclusions of Schultz (1957).

The importance of fin ray counts in the identification of frogfishes is evident when one studies table 1. I have added, therefore, the new counts made on the specimens listed below to my table 1 published in 1957. Additional counts are recorded from other specimens mentioned elsewhere in this paper as well as some furnished by Dr. Richard Rosenblatt.

Table 1 includes the nomenclatural changes discussed in this report.

Specimens Examined

Antennarius altipinnis

SU 30045, Taruna, Sangi Island, Sangir Islands, Herre, June 24, 1928, 31 mm.
SU 27238, Sitankai, Sulu, Philippines, Herre, August 7, 1931, 32 mm.
SU 27239, Dumaguete, Philippines, Herre, 19 mm.

Antennarius avalonis

CAS [no number], Guaymas, Sonora, Mexico, February 1951, 200 mm.
CAS 6627, latitude 0°55′S., longitude 90°31′W., Hancock Expedition, dredge 58–60 fathoms, Jan. 26, 1934, 68 mm.
CAS [no number], Guaymas, Mexico, D. A. Simpson, April 2, 1946, 3 specimens, 32–50 mm.
SU 9979, Santa Catalina Island, California, holotype of *A. avalonis* Jordan and Starks, 267 mm.
SU 16586, San Carlos Bay, Sonora, Mexico, June 1, 1950, 44 mm.
SU 14968, Rocky Bluff Bay, Sonora, Mexico, 13 mm.

TABLE 1.—*Counts recorded for species of Antennariidae*

Genera, subgenera, and species	Number of fin rays																		
	Soft dorsal						Anal					Pectoral†							
	11	12	13	14	15	16	6	7	8	9	10	7	8	9	10	11	12	13	14
Tathicarpus																			
*butleri**	3	–	–	–	–	–	–	3	–	–	–	3	–	–	–	–	–	–	–
butleri	1	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–
Trichophryne																			
roseaceus	–	2	–	–	–	–	–	1	1	–	–	–	–	–	4	–	–	–	–
*mitchelli**	–	–	1	2	–	–	–	–	2	1	–	–	–	–	1	2	–	–	–
Nudiantennarius																			
subteres	–	1	–	–	–	–	–	1	–	–	–	–	–	2	–	–	–	–	–
Abantennarius																			
duescus	–	2	–	–	–	–	–	2	–	–	–	–	–	4	–	–	–	–	–
analis	–	1	–	–	–	–	–	1	–	–	–	–	–	–	2	–	–	–	–
Rhycherus																			
*filamentosus**	–	–	3	–	–	–	–	–	3	–	–	–	–	–	–	3	–	–	–
Histiophryne																			
*bougainvilli**	–	–	–	–	3	–	–	–	3	–	–	–	3	–	–	–	–	–	–
*scortea**	–	–	–	–	3	–	–	–	3	–	–	–	–	–	1	2	–	–	–
Echinophryne																			
*crassispina**	–	–	–	–	1	1	–	–	2	1	1	–	–	–	1	2	–	–	–
*glauerti**	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	1	–	–	–
Phyneloz																			
Phyneloz																			
*striatus**	–	1	1	–	–	–	1	1	–	–	–	–	–	–	2	–	–	–	–
striatus	–	2	–	–	–	–	–	1	1	–	–	–	–	–	4	–	–	–	–
*melas**	–	2	–	–	–	–	1	1	–	–	–	–	–	–	2	–	–	–	–
scaber	1	49	1	–	–	–	–	50	1	–	–	–	–	–	5	61	–	–	–
lochites, new species	–	4	–	–	–	–	–	4	–	–	–	–	–	–	2	6	–	–	–
Trisentennatus																			
cunninghami	–	1	–	–	–	–	–	1	–	–	–	–	–	1	1	–	–	–	–
zebrinus	–	6	–	–	–	–	1	5	–	–	–	–	–	–	10	1	–	–	–
atra	–	5	–	–	–	–	–	5	–	–	–	–	–	–	9	–	–	–	–
nox	–	7	–	–	–	–	–	7	–	–	–	–	–	–	1	12	–	–	–
tridens	–	42	1	–	–	–	–	43	–	–	–	–	–	–	7	66	4	–	–

TABLE 1.—*Counts recorded for species of Antennariidae*—Continued

Genera, subgenera, and species	Number of fin rays																		
	Soft dorsal						Anal					Pectoral†							
	11	12	13	14	15	16	6	7	8	9	10	7	8	9	10	11	12	13	14
Antennatus																			
Antennatus																			
bigibbus	-	11	3	-	-	-	-	12	1	-	-	-	-	-	2	27	-	-	-
strigatus	-	9	-	-	-	-	-	9	-	-	-	-	-	1	13	2	-	-	-
Golem																			
cryptacanthus	-	1	1	-	-	-	-	2	-	-	-	-	2	-	-	-	-	-	-
Lophiocharon																			
Lophiocharon																			
caudimaculatus	-	1	29	-	-	-	-	28	2	-	-	-	-	46	2	-	-	-	
Unianantennatus																			
campylacanthus	1	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-
horridus	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	2	-	-	-
*horridus**	-	2	2	-	-	-	-	-	3	1	-	-	-	-	1	2	1	-	-
*tenebrosus**	-	1	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-
tenebrosus	-	1	-	-	-	-	-	1	-	-	-	-	-	-	2	-	-	-	-
Antennarius																			
Fowlerichthys																			
radiosus	-	1	79	6	-	-	-	-	82	1	-	-	-	-	-	-	-	107	5
*radiosus**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	51	5
avalonis	-	2	29	1	-	-	-	-	30	1	-	-	-	-	-	-	-	59	-
*sarasa**	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-
ocellatus	-	-	17	-	-	-		-	17	-	-	-	-	-	-	3	26	3	
Antennarius																			
hispidus	-	1	3	-	-	-	-	4	-	-	-	-	-	-	8	-	-	-	-
*moluccensis**	-	-	2	-	-	-	-	-	2	-	-	-	-	-	-	2	-	-	-
moluccensis	-	1	13	-	-	-	-	5	9	-	-	-	-	-	9	17	-	-	-
*leucosoma**	-	1	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-
pardalis	?1	-	-	-	-	-	-	-	78	-	-	-	-	-	71	-	-	-	-
chironectes	1	14	1	-	-	-	2	13	-	-	-	-	-	-	27	-	-	-	-
multiocellatus	1	6	-	-	-	-	1	6	-	-	-	-	-	-	13	-	-	-	-
phymatodes	1	3	-	-	-	-	-	4	-	-	-	-	-	-	6	-	-	-	-
japonicus, new species	-	1	-	-	-	-	-	1	-	-	-	-	-	-	2	-	-	-	-
indicus, new species	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	-
sanguineus	-	-	8	-	-	-	-	6	2	-	-	-	-	-	-	13	3	-	-
drombus	1	21	3	-	-	-	-	24	1	-	-	-	-	-	-	12	36	1	-
coccineus	-	24	-	-	-	-	1	22	-	-	-	-	-	3	43	1	-	-	-
bermudensis	-	2	-	-	-	-	-	2	-	-	-	-	-	2	2	-	-	-	-
*dorehensis**	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-
*notophthalmus**	-	3	-	-	-	-	-	3	-	-	-	-	-	3	1	-	-	-	-
notophthalmus	-	4	-	-	-	-	-	4	-	-	-	-	-	7	1	-	-	-	-
verrucosus	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-	4	-	-	-
altipennis	1	20	1	-	-	-	-	19	3	-	-	-	-	42	5	-	-	-	-
pauciradiatus	-	13	-	-	-	-	-	12	1	-	-	-	2	21	1	-	-	-	-
nummifer	-	22	-	-	-	-	-	22	-	-	-	-	-	-	34	4	-	-	-
Histrio																			
histrio	3	32	2	-	-	-	-	30	2	-	-	-	-	2	72	4	-	-	-

*Counts recorded from literature.

†Counts for both pectorals included when the number exceeds the count for the anal or dorsal rays.

Antennarius chironectes

CAS [no number], Honolulu, E. M. Ehrhorn, 1915, 18 mm.
CAS 6371, Honolulu, E. M. Ehrhorn, 92 mm.
CAS 7400, Honolulu, A. Seale, 1935, 93 mm.
SU 20463, Cagayancillo, Philippines, 63 mm.
SU 8468, Honolulu, *Albatross*, 1902, 2 specimens, 52 and 101 mm.
SU 8439, Laysan Island, holotype of *A. laysanius* Jordan and Snyder, 69 mm.
UH 2338, Waiamae, Oahu, Aug. 12, 1955, 150 mm.

Antennarius coccineus

CAS [no number], Pago Pago, Samoa, A. Seale, May 1929, 72 mm.
CAS [no number], Pago Pago, Samoa, A. Seale, May 1929, 70 mm.
UH 1159, Hull Island, Phoenix Islands, July 12, 1950, 74 mm.

Antennarius drombus

UH 1775, Hauula Park, Oahu, A. Tester, Jan. 21, 1953, one specimen
UH 531, Waikiki, Oahu, Cuttress, April 4, 1950, one specimen
UH 1832, Diamond Head, Oahu, one specimen
UH 1227, Waialea School, Oahu, Feb. 4, 1951, two specimens
UH 816, Diamond Head, Oahu, May 16, 1950, two specimens
UH 1995, Waimea, Oahu, July 25, 1955, 62 mm.
UH 338, Hauula Park, Oahu, June 28, 1949, 26 mm.
UH 1751, Waikiki, Oahu, 40 mm.

Antennarius multiocellatus

SU 52342, Port of Fortaleza, Brazil, Mucuripe, Feb. 23, 1945, 50 mm.

Antennarius moluccensis

CAS [no number], Hawaii, Thayer, Sept. 23, 1909, 111 mm.
CAS [no number], Hawaii, 173 mm.
SU 8455, Honolulu, 53 mm.
SU 8458, Honolulu, *Albatross*, 1902, 84 mm.
UH 148, off Oahu, 162 mm.
UH 1995, Waimea, Oahu, July 25, 1955, 36 mm.
UH 268, Waimea, Oahu, Feb. 22, 1949, 1 specimen
UH 403, Diamond Head, Oahu, Dec. 15, 1949, 87 mm.

Antennarius nummifer

SU 7600, Misaki, Japan, holotype of *A. sanguifluus* Jordan, 44 mm.

Antennaries notophthalmus

SU 27241, Unisan, Tayabas Province, Luzon, Philippines, Herre, Feb. 15, 1924, 2 specimens, 52 mm.

Antennarius sanguineus

SU 14967, Cleopha Island, Tres Marias Islands, Mexico, Feb. 23, 1940, 31.5 mm.

Antennatus bigibbus

SU 27236, Dumaguete, Philippines, Herre, June 20–26, 1931, 2 specimens, 23 and 34 mm.
SU 29562, Mabini, Batangas, Philippines, Herre, March 1933, 34 mm.
SU 8461, Honolulu, O. P. Jenkins, *Albatross*, 3 specimens, 15 and 19 mm.
SU 3247, Honolulu, O. P. Jenkins, 5 specimens, 19 and 24 mm.
UH 338, Hauula Park, Oahu, June 28, 1949, 33 mm.
UH 2100, three miles west of Lahaina, Maui, Aug. 5, 1955, 33 mm.

Antennatus strigatus

CAS W56–236, Clipperton Island, northeast side, Oct. 22–29, 1956, 34.3 mm.
CAS W58–296, Clipperton Island, Aug. 20, 1958, 20 mm. [abnormal dorsal fin with last 4 rays branched]
CAS W58–291, Clipperton Island, west end, Aug. 16, 1958, 22 mm.

Lophiocharon caudimaculatus

CAS [no number or locality], 5 specimens, 57 to 92 mm.
SU 39498, Singapore, Herre, Oct. 10, 1940, 2 specimens, 45 and 83 mm.
SU 30651, Singapore, Herre, March 14, 1934, 4 specimens, 39 to 81 mm.
SU 27872, Sandaken, British North Borneo, Herre, July 3, 1929, 3 specimens, 65 to 87 mm.
SU 32738, Singapore Harbor, Herre, May 7, 1937, 3 specimens, 53 to 69 mm.
SU 35781, Singapore Market, Herre, May 1937, 2 specimens, 84 and 85 mm.
SU 30652, Singapore, Herre, 2 specimens, 52 and 80 mm.
SU 20204, Cuyo, Philippines, R. C. McGregor, holotype of *A. lithinostomus* Jordan and Richardson, 84 mm.

Phrynelox atra

CAS [no number or locality, identification uncertain], 82 mm.
SU 9234, Port Jackson, Australia, 1 specimen
SU 3259, Honolulu, Jenkins, 1889, 60 mm.

Phrynelox nox

SU 7601 Japan, cotype of *A. nox* Jordan, 61 mm.
SU 7603, Nagasaki, Japan, holotype of *A. nox* Jordan, 84 mm.
SU 7599, Misaki, Japan, two cotypes of *A. nox* Jordan, 58 and 60 mm.

Phrynelox scaber

CAS 8819, Green Turtle Bay, Bahamas, 67 mm.

Phrynelox striatus

SU 9138, Port Jackson, Australia, 106 mm.
SU 20725, Lake Illawarra, Australia, 87 mm. [bait is abnormal with 5 branches]

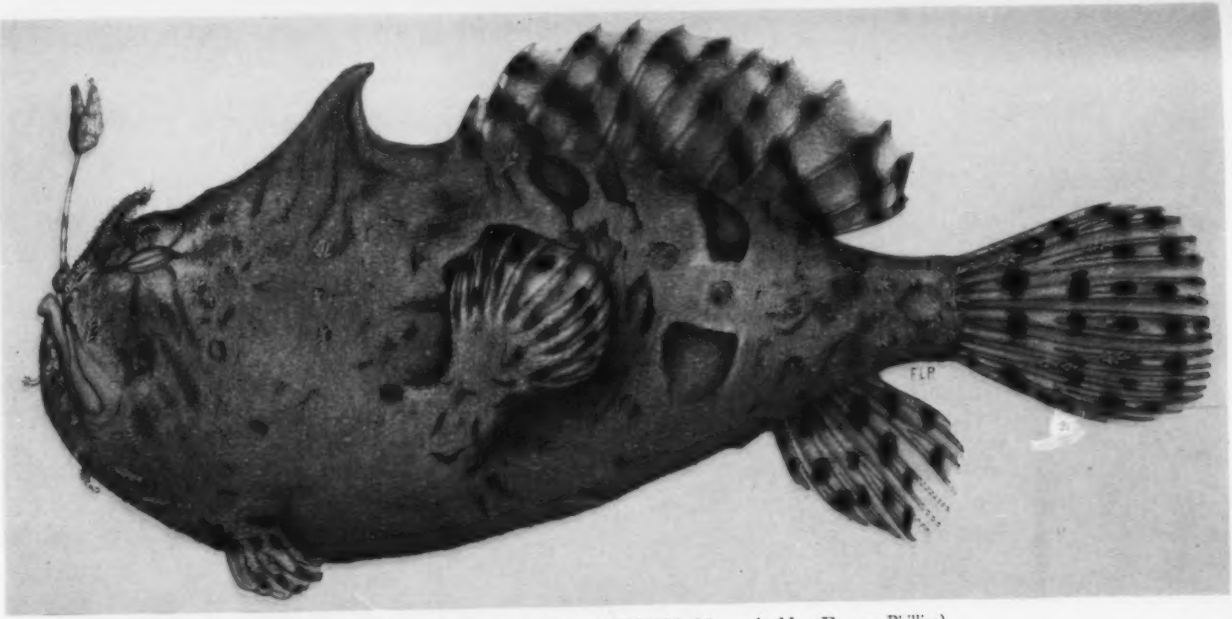

PLATE 1.—*Phrynelox lochites*, holotype, SU 38194 (drawn by Mrs. Fanny Phillips).

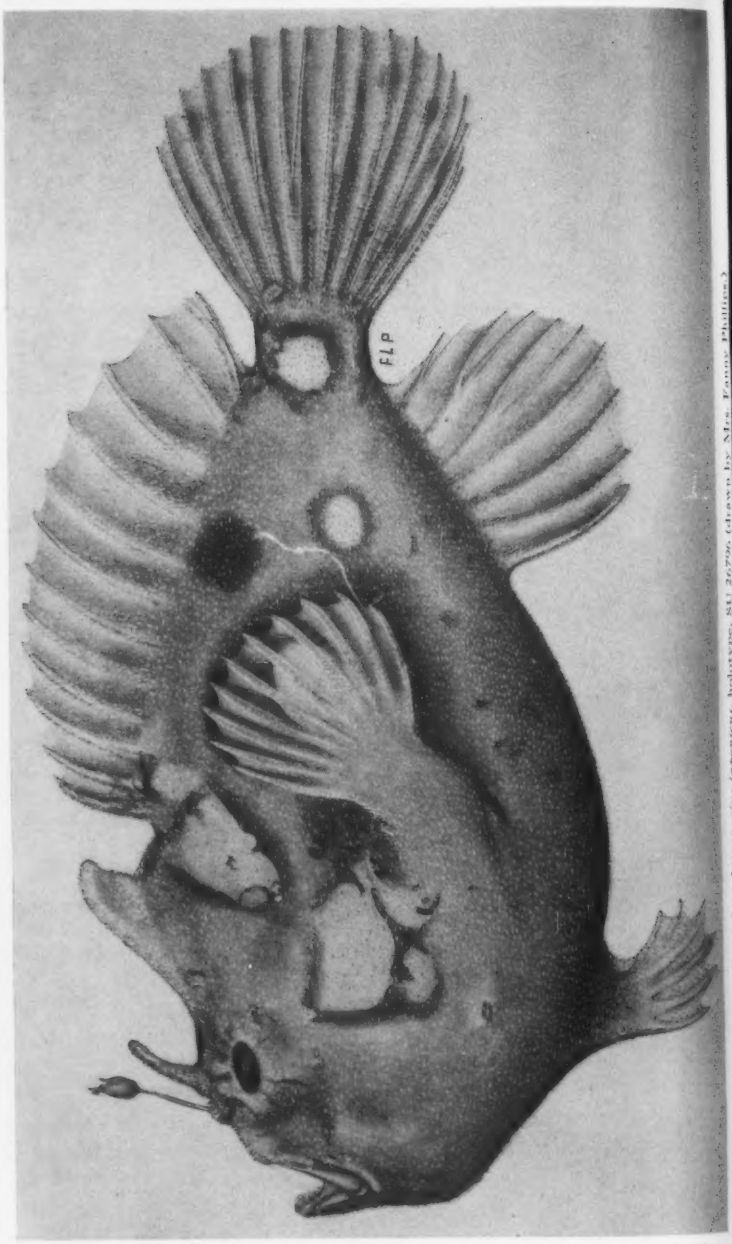

PLATE 2.—*Antennarius japonicus*, holotype, SU 26796, (drawn by Mrs. Fanny Phillips.)

PLATE 2.—*Antennarius japonicus*, holotype, SU 26796 (drawn by Mrs. Fanny Phillips.)

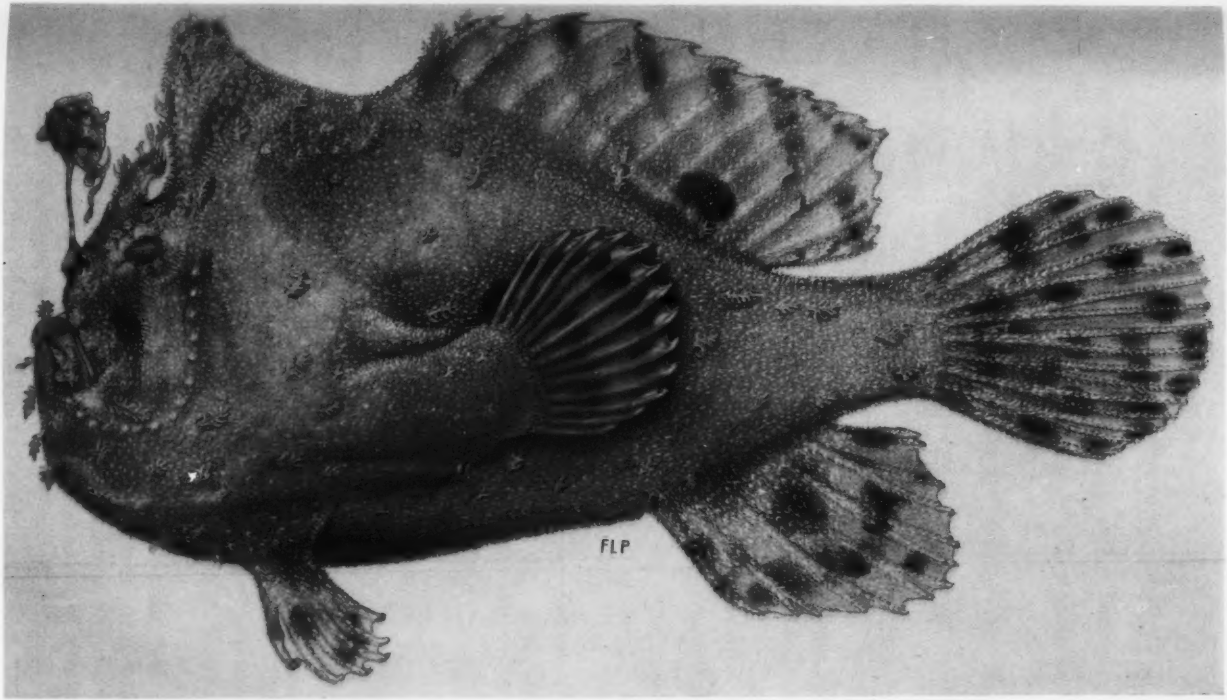

PLATE 3.—*Antennarius indicus*, holotype, SU 40090 (drawn by Mrs. Fanny Phillips).

Phrynelox tridens

CAS [no number], Tateyama Bay, Chiba Prefecture, Japan, Terazaki, Aug. 29, 1946, 59 mm.
CAS [IU 10680] Misaki, Sagami, Japan, Jordan and Snyder, 3 specimens, 49 to 52.5 mm.
SU 32414, Tinghai, Chusan Island, Chekiang Province, China, 2 specimens, 47 and 63 mm.
SU 25636, Nagasaki, Japan, 39 mm.
SU 7227, Nagaski, Japan, 18 specimens, 27 to 59 mm. [one specimen has 4 tentacles]
SU 7228, Wakanoura, Japan, 7 specimens, 53 to 78 mm.
SU 23424, Wakanoura, Japan, 5 specimens, 42 to 59 mm.

Nomenclatural Changes

Three new frogfish names have been published since my review. Cadenat (Bull. Inst. Francais Afrique Noire, vol. 21, ser. A., no. 1, pp. 361–385, figs. 1–26, 1959) described *Antennarius* (*Fowlerichthys*) *senegalensis*, *A.* (*Triantennatus*) *delaisi*, and *A.* (*T.*) *occidentalis* as new species from off the west coast of Africa.

Golem Whitley

Xenophrynichthys Schultz (synonym).

The generic name *Golem* Whitley (type species, *Antennarius cryptacanthus* Weber), published May 8, 1957 (Proc. Roy. Zool. Soc. New South Wales, p. 70) has priority over *Xenophrynichthys* Schultz (Proc. U.S. Nat. Mus., vol. 107, no. 3383, p. 81, November 1, 1957), both with the same type species.

Antennarius radiosus Garman

Kanazawaichthys scutatus Schultz (synonym).

In 1957 (op. cit., p. 63) I described *Kanazawaichthys scutatus* on prejuvenile specimens, characterized by having two pairs of enlarged bony plates on the head. Hubbs (Copeia, no. 4, pp. 282–285, 1958), with additional specimens and aided by me in a restudy of still more specimens, concluded that *K. scutatus* is the prejuvenile of *A. radiosus*, an opinion with which I concur.

Maul (Bocagiana, Mus. Mun. Funchal, no. 1, p. 15, 1959) records a large specimen of *A. radiosus* from Madeira, and Palmer (Ann. Mag. Nat. Hist., ser. 13, vol. 3, pp. 149–151, 1960) records a prejuvenile *A. radiosus*, 13 mm. in standard length, off the West Coast of Ireland, 54°10′ N., 12°10′ W.; thus, this western Atlantic species occasionally occurs in the eastern part of the Atlantic Ocean.

Lophiocharon Whitley

Plumantennatus Schultz (synonym).

Lophiocharon caudimaculatus (Rüppell)

Antennarius asper Macleay (synonym).

The main character I used for the separation of *L. caudimaculatus* (subgenus *Lophiocharon*) and *L. asper* (type of the subgenus *Plumantennatus*) was a supposed difference in the bait, a simple tentacle in the former and a plumelike bait in the latter. I now find the nature of the bait to be variable, from simple to plumelike, and, therefore, I synonymize *Antennarius asper* Macleay with *L. caudimaculatus* (Rüppell) and the subgenus *Plumantennatus* Schultz (1957, p. 89) with *Lophiocharon* Whitley.

The usual color pattern of *L. caudimaculatus* is that figured by Schultz (1957, pls. 6, A, D, and 8, C) with or without an ocellate spot just behind the midbase of the soft dorsal fin; otherwise, the entire fish is brown-speckled or reticulated with brown. The chief distinguishing coloration, however, is in the caudal fin and consists of white or clear spots encircled with brown or blackish pigment.

The following specimens were studied at the Department of Systematic Biology, Stanford University (SU): SU 35781, Singapore Market, May 1937, A. W. Herre, two, 84 and 85 mm. standard length; 30652, Singapore, A. W. Herre, two, 52 and 80 mm.; 20204 (holotype of *A. lithinostomus* Jordan and Richardson), Cuyo, Philippine Islands, R. C. McGregor, 84 mm.; 39498, Singapore, October 10, 1940, A. W. Herre, two, 45 and 83 mm.; 30651, Singapore, March 14, 1934, A. W. Herre, four, 39 to 81 mm.; 27872, Sandaken, British North Borneo, July 3, 1929, A. W. Herre, three, 65 to 87 mm.; 32730, Singapore Harbor, May 7, 1937, A. W. Herre, three, 53 to 68 mm. At the California Academy of Sciences (CAS) (without number or locality), five specimens measured 57 to 92 mm.

Among the 26 specimens examined, I find that 6—SU 30652 (2), 32730 (3), and CNHM 47248 (1)—represent a black color phase described as follows: general background coloration black, tentacle barred, bait white; white saddle in front of first soft ray of dorsal fin reaching to level of eye; white blotches just behind corner of mouth, above base of pectoral fin, near tips of third dorsal spine, near tips of rays of caudal, pectoral, and posterior rays of both soft dorsal and anal fins; white bar between rear of bases of soft dorsal and anal fins, and another white bar across base of caudal fin rays; sometimes rear third of caudal fin white and posterior margins of pectoral, pelvic, anal, and dorsal fins white; a few circular white spots may, or may not, occur in black area on middle of caudal fin.

***Antennarius phymatodes* Bleeker**

***Antennarius oligospilos* Bleeker (synonym).**

In my review (1957), I recognized as distinct species *A. phymatodes* and *A. oligospilos* on the basis of characters supposedly shown in Bleeker's illustrations. Recent correspondence with Dr. Boeseman, along with information published by Dr. de Beaufort (The Fishes of the Indo-Australian Archipelago, vol. 11, pp. 204–206, 1962), conclusively show that *A. phymatodes* and *A. oligospilos* represent the same species.

These conclusions are based on the very close similarity of the holotypes of the nominal species as follows:

A. phymatodes Bleeker, RMNH 6285, holotype (illustrated in Bleeker's Atlas, plate 199, fig. 5, 1865), standard length 69 mm., total length 93 mm.; dorsal rays III,12, last 2 branched; anal 7, all branched; pectorals 10–10, none branched; pelvics I,5, last ray branched; caudal 9, all branched.

A. oligospilos Bleeker, RMNH 6286, holotype, standard length 63 mm., illustrated (slightly modified after the 68 mm. nontype smaller of two specimens in RMNH 25010) as plate 195, fig. 1, in Bleeker's Atlas; dorsal rays III,12, last 2 rays branched; anal 7, all branched; pectoral 10–10, none branched; pelvics, I,5, last ray branched; caudal 9, all branched.

Description of New Species

***Phrynelox lochites*, new species**

PLATE 1

This new species of *Phrynelox* with short "bait" (about the same length as the second dorsal spine) from the Philippine Islands has as a cognate species its closest relative, *P. scaber* of the western tropical Atlantic Ocean.

Holotype, SU 38194, Dapitan Bay, Mindanao Island, Philippines, August 1940, collector A. W. Herre, standard length 48.5 mm. Three paratypes, all with same locality data as holotype: SU [number unavailable], two specimens, 33.5 and 40.0 mm.; and USNM 197325, 39 mm.

The following counts were made: dorsal soft rays 12, anal 7, branched caudal 4+5, in all specimens; pectoral rays 11–11 in holotype and in two paratypes, 10–10 in one paratype.

Measurements made on the types are recorded in table 2.

Bony part of first dorsal spine a little longer than the second dorsal spine, bearing at its tip the fleshy bait, consisting of two robust tentacles, each with numerous small papillae; skin just behind base of second dorsal spine naked; third dorsal spine movable posteriorly, tip

free, but bound down with skin anteriorly, and subequal in length to second spine; soft dorsal rays all simple except last one or two, which are branched; only last pelvic ray divided; caudal rays branched; anal rays all divided; pectoral rays all simple; gill opening close to base of pectoral fin; caudal peduncle distinct but short, slightly deeper than long; skin thickly covered with bifid to multifid prickles; scattered dermal cirri present.

Color in alcohol: head, body, and fins with light tan background; everywhere, except on underside of head and belly, with black spots or elongate blotches, arranged somewhat in lines on sides of body; black spots on fins round, those on caudal fin forming 4 vertical rows.

In the genus *Phryneloz*, this new species is a member of the subgenus *Phyrnelox*, which is characterized by having the "bait" formed of bifid tentacles. In this subgenus the species fall into two groups: (1) those species with the bony part (illicium) of the first dorsal spine notably long, almost twice the length of the second dorsal spine, including *P. striatus* (Shaw) and *P. melas* (Bleeker); (2) those species

TABLE 2.—*Measurements made on three new species of frogfishes (recorded in thousandths of the standard length)*

	Phryneloz lochites				*Antennarius*	
					indicus	*japonicus*
Characters	Holotype	Paratypes			Holotype	Holotype
Standard length in mm.	48.5	40.0	39.0	33.5	44.5	40
Greatest depth of body	495	625	590	532	548	530
Length of bony part of 1st dorsal spine	165	175	162	179	135	113
" " " " " 2nd " "	124	150	115	164	168	143
" " " " " 3rd " "	124	150	103	143	207	208
Longest soft dorsal ray	208	238	205	239	265	204
Longest (middle) caudal ray	289	337	318	338	355	305
Head (snout to gill opening)	474	575	640	686	524	550
Length of caudal peduncle (or distance between vertical lines through caudal fin base and rear bases of anal-dorsal fins)	103	112	103	119	115	99
Length of maxillaries	217	250	205	209	236	245
Least depth of caudal peduncle	124	145	115	119	153	123
Length of base of soft dorsal fin	454	550	474	538	540	517
Eye diameter	41	50	72	60	56	75
Interorbital space	144	132	141	134	157	106

with the bony part of the bait from a little longer to about the same length as the second dorsal spine, including *P. scaber* (Cuvier) of the western Atlantic and the black color phase of this species, known formerly as "*P. nuttingi* Garman."

All of the species of the first group that are known so far are from the western Pacific and Indian Oceans, whereas, in the second group, only *P. lochites* is found in the western Pacific, the remainder being found in the Atlantic. *P. lochites* differs from its closest relative in the Atlantic, *P. scaber*, in having the bait about as long as the eye diameter instead of its being two or more times longer. The only color difference noted is that on the caudal and anal fins, the spots being smaller and in more regular rows than those in *P. scaber*.

The species is named *lochites* ("lochites," masculine, Greek, meaning "lying in wait for their prey") to refer to the habit of frogfishes.

Antennarius japonicus, new species

PLATE 2

Holotype, SU 26796, Sagami Bay, Japan, collector A. Owston, only known specimen, 49 mm. standard length.

The following counts were made: dorsal soft rays 12, all simple or unbranched; anal 7, first 3 simple, last 4 branched; caudal 4+5, all branched; pectoral 10–10, all simple; pelvic rays I,5, last branched.

Bony part of first dorsal spine shorter than second dorsal spine, bearing a tuft of tentacles at the tip; skin just behind second dorsal spine naked; third dorsal spine movable and longer than second spine; gill opening close to base of pectoral fin; caudal peduncle distinct but short, deeper than long; skin thickly covered with bifid to multifid prickles; scattered dermal cirri present.

Color in alcohol: background coloration light gray with six round, brown-edged white areas; one on rear of head with two smaller round ones below, in front of pectoral base; another below space between third dorsal spine and origin of soft dorsal fin, and two on side of body; a large dark spot on body below bases of 8th to 10th rays of dorsal fin; color greatly faded but dorsal, anal, and caudal fins show traces of light brown spots; area above base of pectoral fin brownish, with light center.

Remarks: This species traces through my key of the Antennariidae (1957, pp. 53–62) to section 35a, but it differs at this point by having the first dorsal spine shorter than the second dorsal spine. Also, this species differs from *Antennarius pardalis* (section 36a) by having 12 dorsal rays, and from *A. pardalis* and *A. bermudensis* (section 36b) by having a distinctive color pattern of large round white spots.

The new species differs from *A. sarasa* Tanaka (section 33b) in having all dorsal rays simple and 10 pectoral rays, whereas, in the

Japanese species, 8 of the dorsal rays are branched and there are 13 pectoral rays.

Another species recorded from Japan, *A. nummifer* (section 51b), is close to this new species, but it differs in having all of the anal rays divided and the last 2 or 3 dorsal rays divided at their tips. The number of fin rays in the two species agrees but the color pattern of *A. nummifer* does not show round white spots like those of *A. japonicus*.

This species is named *japonicus* in reference to the country where the holotype was collected.

***Antennarius indicus*, new species**

PLATE 3

Holotype, SU 40090, Vizagapatam, India, Dec. 25, 1940, collector A. W. Herre, only known specimen, 44.5 mm. standard length.

The following counts were made: dorsal rays 12, last 2 branched; anal 7, all branched; caudal 4+5, all branched; pectoral 13–13, all simple; pelvic rays I,5, last ray branched.

Bony part of first dorsal spine shorter than second dorsal spine, bearing a tuft of tentacles at tip; skin just behind second dorsal spine naked; third dorsal spine movable and slightly longer than second spine; gill opening close to base of pectoral fin; caudal peduncle distinct, deeper than long; skin thickly covered with bifid to multifid prickles; scattered dermal cirri present.

Color in alcohol: background coloration gray, with a dark spot in middle of side of body, belly plain light gray; anal and caudal fins with scattered dark spots; outer third of dorsal fin with 6 dark bars, and a larger dark spot between bases of 7th to 9th ray; dorsal surface of pectoral fin with dark spots except tips of rays white, underside of pectoral uniformly light gray; body appears to have had other dark markings, now indistinct.

Remarks: This species traces through my key of the Antennariidae (1957, pp. 53–62) to section 49b, but it differs from section 50a (*A. verrucosus*) and 50b (*A. altipinnis* and *A. pauciradiatus*) by having 13 pectoral fin rays, instead of 9–11, a difference thought to be of significance in this family. Among the various species referable to the subgenus *Antennarius*, only two have as many pectoral rays as 12 or 13: *A. sanguineus* from the eastern Pacific and *A. drombus* from Hawaii and Cocos Island. The caudal peduncle in both species is very short, its depth 2½ or 3 times its length, whereas, in *A. indicus*, the depth is 1¾ its length. The lower sides and belly of *A. drombus* and *A. sanguineus* are dark-spotted, whereas *A. indicus* lacks spots ventrally.

The new species is named *indicus* in reference to the country where the holotype was collected.

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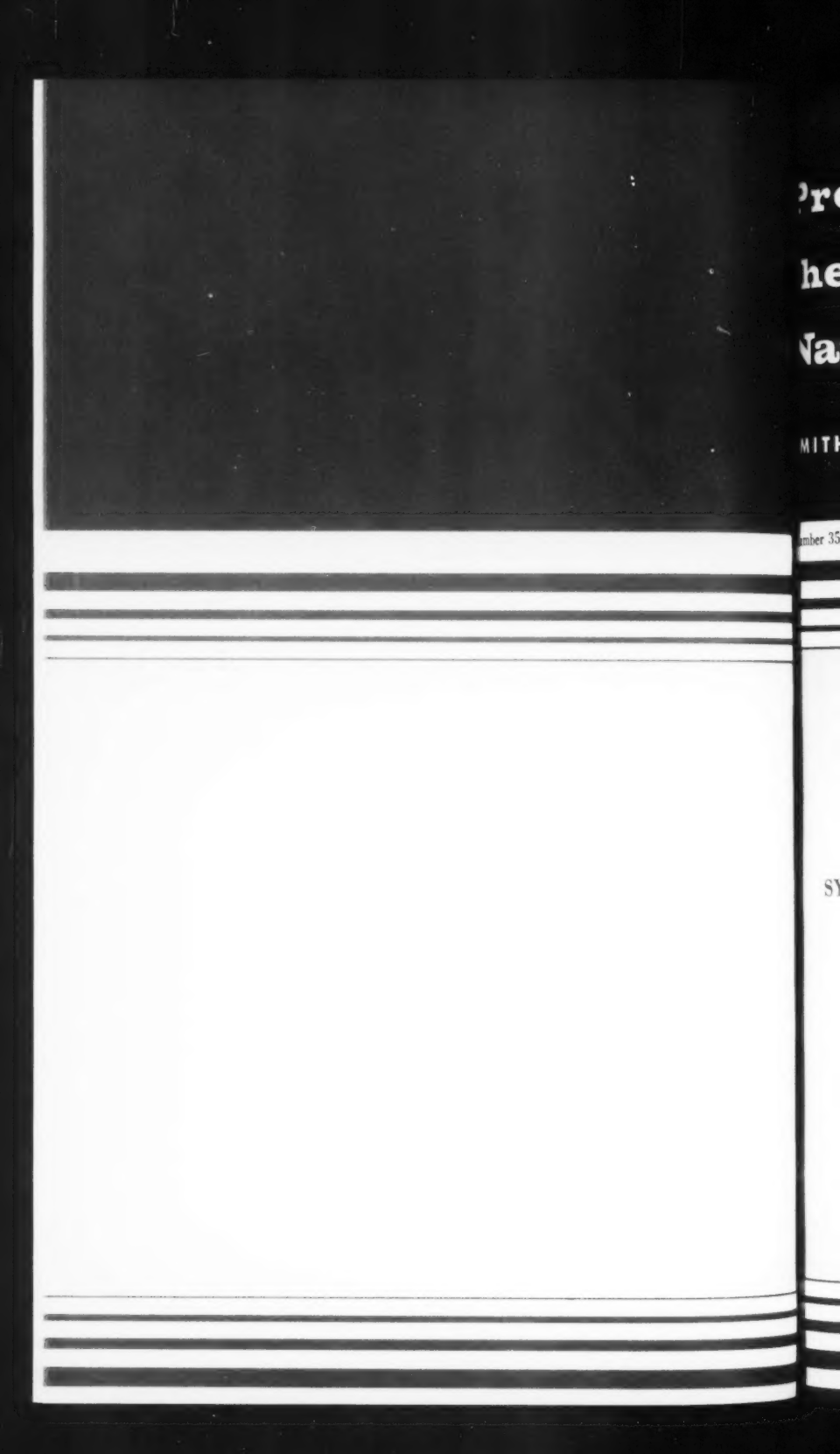

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NEOTROPICAL MICROLEPIDOPTERA, V

SYNOPSIS OF THE SPECIES OF THE GENUS PROEULIA FROM CENTRAL CHILE (LEPIDOPTERA: TORTRICIDAE)

By NICHOLAS S. OBRAZTSOV

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NEOTROPICAL MICROLEPIDOPTERA, V

SYNOPSIS OF THE SPECIES OF THE GENUS PROEULIA FROM CENTRAL CHILE (LEPIDOPTERA : TORTRICIDAE)[1]

By Nicholas S. Obraztsov

The Neotropical species usually referred to the genera *Eulia* Hübner, *Tortrix* Linné, and *Cnephasia* Curtis actually have little in common with these Holarctic genera. Some of these species have been relegated recently to the genera *Argyrotaenia* Stephens, *Subargyrotaenia* Obraztsov, *Proeulia* Clarke, *Anopina* Obraztsov, and others, but the generic position of many species still remains uncertain. Five new species from Central Chile described in this paper and four already known are assigned to the genus *Proeulia*. Additional information is included here concerning the previously described species.

The genus *Proeulia* was established recently for two species from the Juan Fernandez Islands (Clarke, 1963). The characters of this genus, originally based on a study of its type, *P. robinsoni* (Aurivillius),

[1] Prepared with the aid of a National Science Foundation Grant. Previous parts of this same series are: I and II, Clarke, 1962, Proc. U.S. Nat. Mus., vol. 113, no. 3457, pp. 373–388; III, Clarke, 1964, ibid., vol. 115, no. 3480, pp. 61–84; IV, Duckworth, 1964, ibid., vol. 116, no. 3497, pp. 97–114.

731-763—64

and *P. griseiceps* (Aurivillius), have been confirmed by the additional nine species from Central Chile examined by the present author. Only in the description of the wing venation are some modifications necessary. In the original diagnosis of *Proeulia*, the veins R and M_1 of the hindwing were described as stalked, and they are similar in most of the species treated in the present paper. In the new species *Proeulia triquetra*, however, these veins are either variously long-stalked, or originating connate, or even slightly separate, although closely approximated to each other in the basal portions. Also, veins M_3 and Cu_1 of the hindwing are either connate (as in *P. robinsoni* and *P. griseiceps*) or slightly separate at origin. In view of the observed individual variation of these characters in one and the same species, it seems to be expedient to extend the diagnosis of the genus to include all these modifications.

The study of the nine additional species assigned to this genus has demonstrated some important specific modifications in the shapes of certain parts of the genitalia, as is seen from the descriptions and photographs in this paper. The most unusual is the process that projects from the ventral surface of the bursa copulatrix, exhibiting a greater reduction in *Proeulia griseiceps* than in *P. robinsoni*. In *P. auraria* (Clarke), *P. chrysopteris* (Butler), and *P. apospasta*, new species, this process is very short. It is quite possible that in some species not yet known this reduction may appear to be even more complete. In *P. leonina* (Butler) and *P. aethalea*, new species, the above process is especially well developed. The location of this process close to the inception of the ductus seminalis and its connection with the surrounding sclerotization supports the identification of this structure as a cestum, developed in the present case as an external protrusion. The area around the ostium oviductus generally is sclerotized somewhat in all species of *Proeulia*. The corresponding sclerite is reversely subcordate as a rule and probably represents a modification of the papillae genitales known in some other families of the Lepidoptera (Kusnezov, 1916). This structure still is studied poorly in the Tortricidae and probably will be found in other genera of this family.

It is a pleasure for the author to express his gratitude to Dr. J. F. Gates Clarke of the U.S. National Museum and Mr. J. D. Bradley of the British Museum (Natural History) for the materials placed at his disposal and to Dr. J. G. Rozen and Dr. F. H. Rindge of the American Museum of Natural History for providing the necessary working facilities. The work on this paper was done under the auspices of the National Science Foundation; many of the specimens involved in the study were collected by Dr. Clarke during field investigations supported by the National Science Foundation.

Key to the Species of *Proeulia* from Central Chile

1. Forewing unicolorously ocherous with some few, little, scattered black dots 2
   Forewing not ocherous; if ocherous, more markings, expecially at dorsum, are present 3
2. Hindwing pale ocherous, at base with a concolorous or slightly darker tuft of hairs; sacculus not protruding valva . . . . . **leonina** (Butler)
   Hindwing shiny white, at base with a white tuft of hairs; sacculus protruding valva. . . . . **cneca,** new species
3. Forewing with two bands originating at costa and meeting each other at a point slightly remote from dorsum . . . . . **tenontias** (Meyrick)
   Forewing without such bands 4
4. Dorsum of forewing with a large triangular spot connected with wing base by means of a band along dorsum; hindwing dark hazel grayish to dark lead gray . . . . . **triquetra,** new species
   Dorsum without any defined spot; if such is present, not connected with wing base; hindwing whitish or somewhat fuscous, never very dark . . 5
5. Forewing dark fuscous, diffusely shaded, without defined markings. **aethalea,** new species
   Forewing of some other color; markings more or less distinct and consisting either of a dorsal spot or of some (at least incomplete) bands and/or reticulation, or all these markings present 6
6. Forewing with a ferruginous blotch in basal portion; an oblique, white line closely basad from dorsal spot . . . . . **apospasta,** new species
   Forewing without ferruginous blotch in basal portion and no white line basad from dorsal spot. 7
7. Sacculus protruding valva and ending with a free, sharp point. **chrysopteris** (Butler)
   Sacculus not protruding valva and not pointed at tip 8
8. External margin of valva curved in lower portion and reaching end of sacculus vertically; shorter cornutus longer than one-half length of long cornuti. **inconspicua,** new species
   External margin of valva not perceptably changing its direction from apex to end of sacculus; shorter cornutus less than one-half length of long cornuti. **auraria** (Clarke)

Proeulia leonina (Butler), new combination

PLATE 1

Sciaphila leonina Butler, 1883, Trans. Ent. Soc. London, p. 69.
Tortrix leonina, Meyrick, 1912, *in* Wagner, Lepidopterorum catalogus, pt. 10, p. 27; 1913, *in* Wytsman, Genera insectorum, fasc. 149, p. 29.

Male genitalia: Uncus rather short; socii long, gradually and moderately dilated. Fultura superior narrow; fultura inferior high and rather narrow. Valva broad; sacculus moderate, pointed, not protruding valva. Aedeagus moderately thickened, with tip rounded; three long cornuti, one longer than remaining two.

Female genitalia: Lamella antevaginalis large, deeply incised at middle, covering ostium bursae. Antrum large, subrectangular.

Corpus bursae elongate-ovate, with a large, lateral swelling bearing a well-developed cestum; cervix bursae broad and short. Sclerotization around ostium oviductus well developed.

Types: Lectotype, male (genitalia on slide 8641), Valparaiso, Chile, November 1881 (T. Edmonds, 1882-107); lectoallotype, female (genitalia on slide 8776), same data; British Museum (Natural History).

Other specimens examined: One male and two females, Chile (T. Edmonds, Druce Collection, 1917-36); one female (genitalia on slide 6711), Quillota, Valparaiso, Chile, 1886 (Paulson, 68384); British Museum (Natural History).

Proeulia auraria (Clarke), new combination

PLATES 2, 3

Eulia auraria Clarke, 1949, Acta Zool. Lilloana, vol. 7, p. 583, pl. 2, figs. 6-6b.

The original description of this species was based on a series of six male specimens, all of them taken in Cajón de Maipo, Santiago. Many additional specimens examined for the present paper originated from other localities, showing that the species is rather variable. The length of the forewing varies from 7 to 12 mm. Most of the small specimens (the type series included) have the forewing markings reduced to an incomplete oblique band running from the middle of the costa toward the tornus and sending from slightly below its middle a short band directed toward the middle of the dorsum. These bands are generally underdeveloped, and only some of their elements are present in each specimen. In some specimens the dorsal portions of the above-mentioned bands form a more or less distinct dorsal triangle or a semicircular arch, some outlines of which are dilated and more intensively dark colored, forming blackish-brown spots. In addition, one more band may be present, running externally to the oblique costotornal band and parallel to it. Occasionally all or some of the bands are widely dilated, and/or some minute, brownish, or ferruginous streaks at the costa and dorsum are present. The golden-ocherous ground color of the forewing is more or less mottled with brown or ferruginous, which causes development of a fine reticulation or separate spots or short lines. Rarely the two basal thirds of the forewing or even the entire forewing are overlaid with brown. Upper basal angle of the forewing commonly differs from the ground color of the wing and is brown, gray, or yellowish. The hindwing is white, ocherous white, or pale cinereous, in some specimens distinctly speckled with gray.

Male genitalia: Uncus rather long, slightly bent; socii dilated externally. Fultura superior narrow; fultura inferior moderately

high. Valva elongate, gradually bent upward and slightly narrowed apicad; sacculus moderate, somewhat tapering apicad, not free pointed. Aedeagus rather stout; from two to four long cornuti, one short, slightly curved, less than half length of long cornuti.

Female genitalia: Lamella antevaginalis band shaped, narrowed laterad; lamella postvaginalis semimembranous. Antrum not developed. Corpus bursae somewhat ovate, scobinate; cestum shaped as a short, rotundate projection with a moderately sclerotized base; cervix bursae broad and short. Sclerotization around ostium oviductus ∧-shaped.

Types: Holotype, male (genitalia on slide), and three male paratypes in USNM. One male paratype in the British Museum (Natural History). One male paratype (not seen by the present author) in the collection of F. Bourquin. All were collected in Cajón de Maipo, Santiago, Chile, Jan. 12–20, 1948 (Don Tito Ramírez).

Other specimens examined: One male, Chile Centro-Austral, January–March 1898 (V. Izquerdo), in USNM. Five males (genitalia of two on slides 6694 and 6703), and two females (genitalia of one on slide 6710), Coquimbo, Chile, July 1–Oct. 19, 1883 (Walker, 3021–3024, 3000, 3205), and May 1884, bred from *Aristolochia chilensis* (Walker, 3234); two males (genitalia of one on slide 6760) and one female, Valparaiso, Chile, Mar. 22–Apr. 13, 1882, Sept. 30–Oct. 8, 1883 (Walker, 2353, 2359, 3078); six males (genitalia of one on slide 6693), Quillota, Valparaiso, Chile, 1886 (Paulson, 68013–68018); the foregoing 15 specimens are deposited in the British Museum (Natural History). Five males (genitalia of one on slide, 21–Obr., 1962), Guayacán, Santiago, Chile, 1100 m., Jan. 25–26, 1951, October 1952 (L. E. Peña); two males (genitalia on slides, 1–Obr., 1962, and 2–Obr., 1962), La Obra, Santiago, Chile, October 1952 (L. E. Peña); one male (genitalia on slide, 22–Obr., 1962), El Principal, Chile,[1] November 1888 (V. Izquerdo); all eight specimens are in USNM.

Remarks: The holotype and its genitalia were figured by Clarke (1949). The shape of the valvae became distorted slightly on the original photograph, and they look more narrow apicad than they really are. The holotype has three long cornuti, but this number varies in the species. In one of the males examined (slide, 1-Obr., 1962) there are only two long cornuti; another male (slide, 21-Obr., 1962) has four of them. The presence of a short, slightly bent cornutus is apparently constant for the species. The variation of the number of

[1] Because the collector is deceased, there is probably no way of ascertaining exactly this location. *Gazetteer* (no. 6, Chile, Office of Geography, Department of the Interior, Washington, August 1955, p. 107) lists two names, one located at 33.47 S. and 70.30 W., the other at 33.42 S. and 70.34 W.

the cornuti and the forewing markings are independent from each other.

***Proculia aethalea*, new species**

PLATE 4

Antenna fuscous. Labial palpus pale brownish gray, speckled with dark fuscous. Head fuscous touched with gray. Thorax grayish brown. Abdomen brownish gray with a dark brown transverse line on caudal edge of eighth abdominal tergite. Legs ocherous. Forewing fuscous with indistinct, somewhat olive-brownish or gray-brownish markings apparently consisting of two diffuse, very broad transverse bands inclined basad; cilia dark brownish gray (as seen under magnification, with scales white checked). Underside of forewing grayish ocherous. Length of forewing 11 mm. Hindwing yellowish white, mottled with pale olive brown; an olive-brownish hair brush at base of veins A_2 and A_3; cilia whitish.

Male genitalia: Uncus rather long; socii dilated externally. Fultura superior dilated laterally; fultura inferior triangular, moderately high. Valva elongate with apex directed upward and external margin rather vertical, in lower portion; sacculus rather broad, moderately long, with tip slightly tapering and slightly protruding beyond lower margin of valva. Aedeagus thickened, with a long and broad lower distal portion and a sclerotized margin around orificium; cornuti arranged in two groups: upper of eleven long cornuti, and lower of three cornuti about half as long as upper ones.

Female genitalia: Lamella antevaginalis shaped as a semicircular band dilated toward antrum; lamella postvaginalis weakly sclerotized, forming dorsal surface of funnel of ostium bursae. Antrum large, membranous. Corpus bursae elongate, sclerotized, covered with stronger sclerotized, longitudinal lines and, in caudal portion, with fine scobination; cestum in form of a long, digitate projection arising from a large basal disc located cephalad from cervix bursae. Weak sclerotization around ostium oviductus.

Types: Holotype, male (genitalia on slide, 17-Obr., 1962), La Obra, Santiago, Chile, October 1902 (L. E. Peña), USNM (type no. 66830). Allotype, female (genitalia on slide 6699), Valparaiso, Chile, Sept. 30–Oct. 8, 1883 (Walker, 3080), British Museum (Natural History).

Remarks: This species differs from the remaining known members of the genus in having very indistinct and poorly defined markings on the forewing. The shape of the aedeagus, the set of the cornuti, and the characters of the female genitalia are unique in the genus *Proculia*. The name of this species is derived from the Greek *αιθαλεος*, meaning "smoky."

***Proeulia triquetra*, new species**

PLATE 5

Antenna more or less dark brown. Labial palpus ocherous, more or less strongly mixed with brown, dark brown, somewhat ferruginous brown, or gray brown, occasionally with slight grayish suffusion; on inside pale ocherous, at least at base. Head and thorax brownish ocherous, hazel brown, mahogany brown, or ferruginous brown, often somewhat grayish suffused; posterior scale tuft occasionally more intensively colored. Abdomen fuscous with occasional touch of pale grayish or ocherous; ventral surface usually somewhat paler, occasionally grayish ocherous. Legs hazel grayish, on inside pale ocherous. Forewing brownish ocherous, testaceous, bay, or of some approximate shade, with more or less distinct, brown reticulation; dorsum with a paler, whitish-ocherous, longitudinal streak slightly suffused with brownish ocherous, testaceous, or bay; it originates at wing base and is dilated into a large triangle before tornus; upper margin of this streak is outlined by a narrow, white line, occasionally missing in some places, but constant at inner side of dorsal triangle and acompanied there by a more or less distinct, brownish-ocherous to dark-gray line (or merely a shadow) from inside of triangle; occasionally dorsal streak and its triangle are strongly darkened, and indicated only by above-mentioned white line along their upper margins; area, bordering dorsal streak and reaching discal cell, usually darker than adjacent ground; a brownish or blackish more or less distinct line originating at middle of costa, directed to, or to slightly below, apex of dorsal triangle, then turning toward wing apex; external portion of this line occasionally dilated, outlining poorly defined costal triangle before wing apex; some occasional, minute, blackish strigulae perpendicular to costa and/or dorsum; cilia concolorous with wing ground, occasionally dark grayish checked, or darker tornad, rarely paler at tips; underside of forewing dark brownish gray, at margins brownish ocherous or testaceous; occasionally entire central area somewhat lightened, grayish testaceous. Length of forewing 9–11 mm. Hindwing hazel grayish to lead gray; cilia concolorous or slightly paler, with a fine, more or less dark gray line.

Male genitalia: Uncus rather long; socii strongly dilated and rounded. Fultura superior rather broad; fultura inferior moderately high. Valva elongate, directed obliquely upward; sacculus broad, short, not free pointed. Aedeagus thickened; three long cornuti, and a separate group of 11–12 very short ones.

Female genitalia: Lamella antevaginalis bandlike, narrowed laterally; lamella postvaginalis weakly sclerotized. Antrum wide and short.

Corpus bursae pyriform; scobination chiefly developed at its left side; cestum shaped as a rather narrow, digitate projection on a weakly sclerotized base; cervix bursae broad, tubular. Sclerotization around ostium oviductus well developed.

Types: Holotype, male (genitalia on slide, 7-Obr., 1962), and allotype, female (genitalia on slide, 10-Obr., 1962), Chillán, Nuble, Chile, Nov. 10, 1961 (H. Lister). Paratypes: one female (genitalia on slide, 9-Obr., 1962), San Ignatio, Nuble, Chile, February 1892 (V. Izquerdo); four males (genitalia of one on slide, 5-Obr., 1962), Concepción, Chile, March 3, 16, and 30, 1961 (Trampas); one female, Araucania [Arauco], Chile, March 1, 1892 (V. Izquerdo); three females (genitalia of one on slide, 8-Obr., 1962), Chile (V. Izquerdo; Silva). All specimens are deposited in USNM (type no. 66831).

Remarks: This is the only known *Proeulia* species with a broad dorsal streak on the forewing. In other species, the dorsal triangle is not connected by a streak with the wing base. The genitalia of both sexes of *P. triquetra* have many characters distinguishing it from other species of the genus.

***Proeulia inconspicua*, new species**

PLATE 6 (FIGS. 4–6)

Male: Antenna ocherous with brown annulation. Labial palpus ocherous with slight ferruginous tinge, on inside pale ocherous. Head pale ocherous. Thorax (badly damaged) ferruginous ocherous; tip of tegula ocherous. Abdomen pale ocherous, slightly brownish dorsally. Legs ocherous. Forewing ocherous, irregularly, densely sprinkled with ferruginous; at middle of dorsum a short, broad, ferruginous brown streak inclined basad; an inconspicuous, ferruginous fascia running from middle of costa to tornus; transverse rows of minute, ferruginous dots, in external wing portion; some inconspicuous, minute, ferruginous costal streaks, darker of them located apically; a fine, ferruginous terminal line, gradually becoming obsolete tornad; cilia pale ferruginous ocherous, slightly darker at tornus; underside of forewing ocherous, somewhat ferruginous costad, with transverse rows of inconspicuous, minute, brownish-ferruginous dots. Length of forewing 11 mm. Hindwing very pale fuscous white, almost white, sprinkled with gray; hair tuft on wing base pale gray; cilia concolorous with wing surface.

Female: Unknown.

Male genitalia: Uncus rather long; socii elongate, dilated at middle. Fultura superior moderately and equally broad; fultura inferior almost triangular, moderately high. Valva elongate, directed upward; its external margin vertical, in lower portion; sacculus broad, rounded

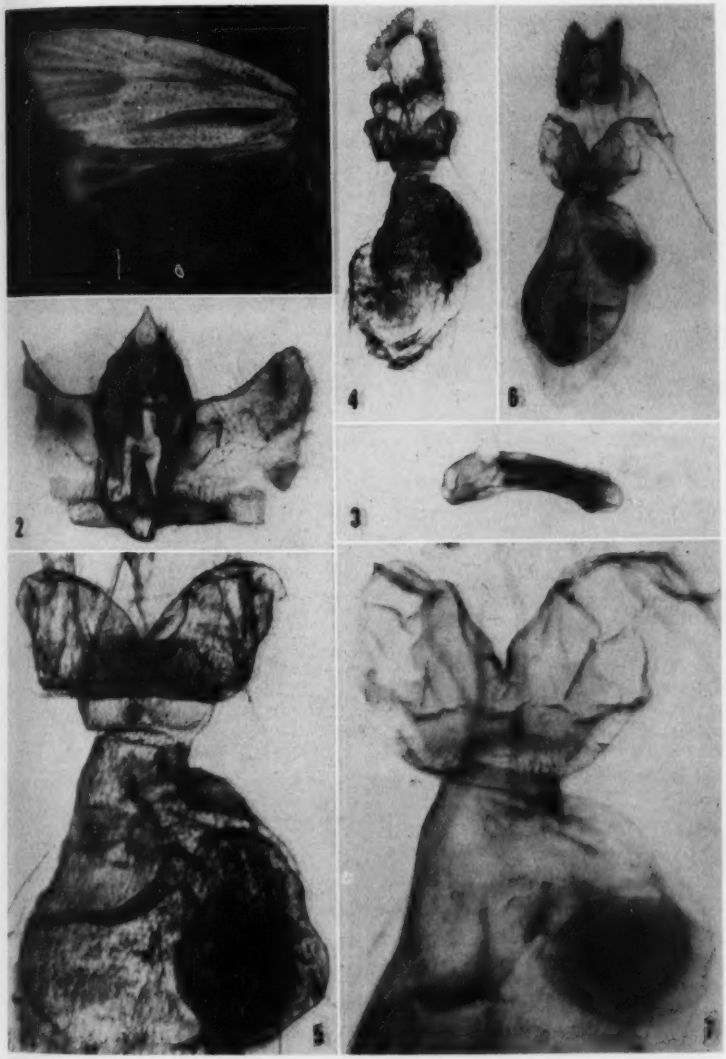


PLATE 1.—*Proeulia leonina* (Butler). Lectotype, male: 1, right wings (image reversed); 2, ventral aspect of genitalia with aedeagus removed; 3, lateral aspect of aedeagus. Lectoallotype, female: 4, ventral aspect of genitalia; 5, detail of bursa copulatrix. Female genitalia of other specimen (slide 6711): 6, ventral aspect of genitalia; 7, detail of bursa copulatrix.

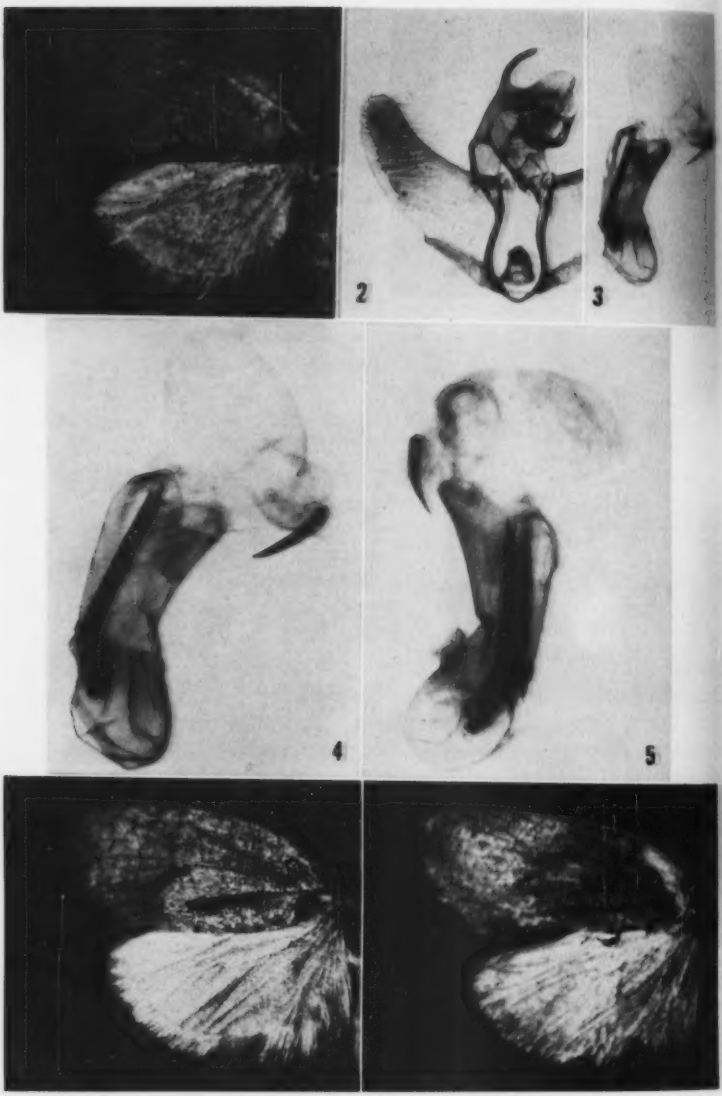
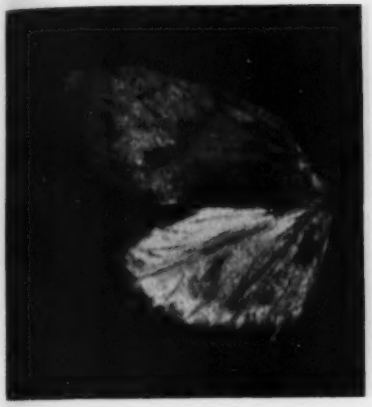
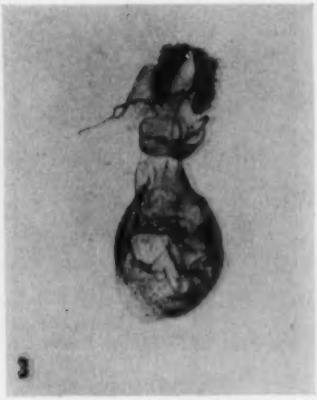


PLATE 2.—*Proculia auraria* (Clarke), males. Specimen from Guayacán, Jan. 25, 1951: 1, left wings. Genitalia (slide, 1-Obr., 1962): 2, ventral aspect with aedeagus removed; 3, lateral aspect of aedeagus; 4, same, greatly enlarged. Aedeagus (slide, 21-Obr., 1962): 5, lateral aspect greatly enlarged. Right wings of two specimens (images reversed): 6, from El Principal, November 1888; 7, from Valparaiso, March 22–April 13, 1882.





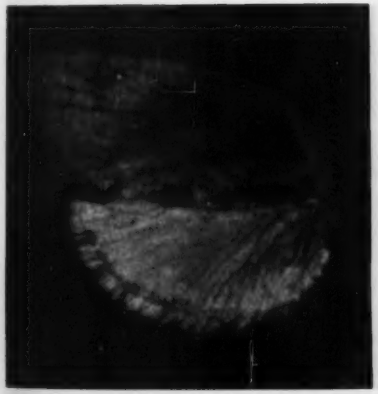


PLATE 3.—*Proculia auraria* (Clarke). Left wings of two specimens: 1, male from Quillota, 1886; 2, female from Coquimbo, July 1–Oct. 19, 1883. Female genitalia (slide 6710): 3, ventral aspect; 4, detail of bursa copulatrix.

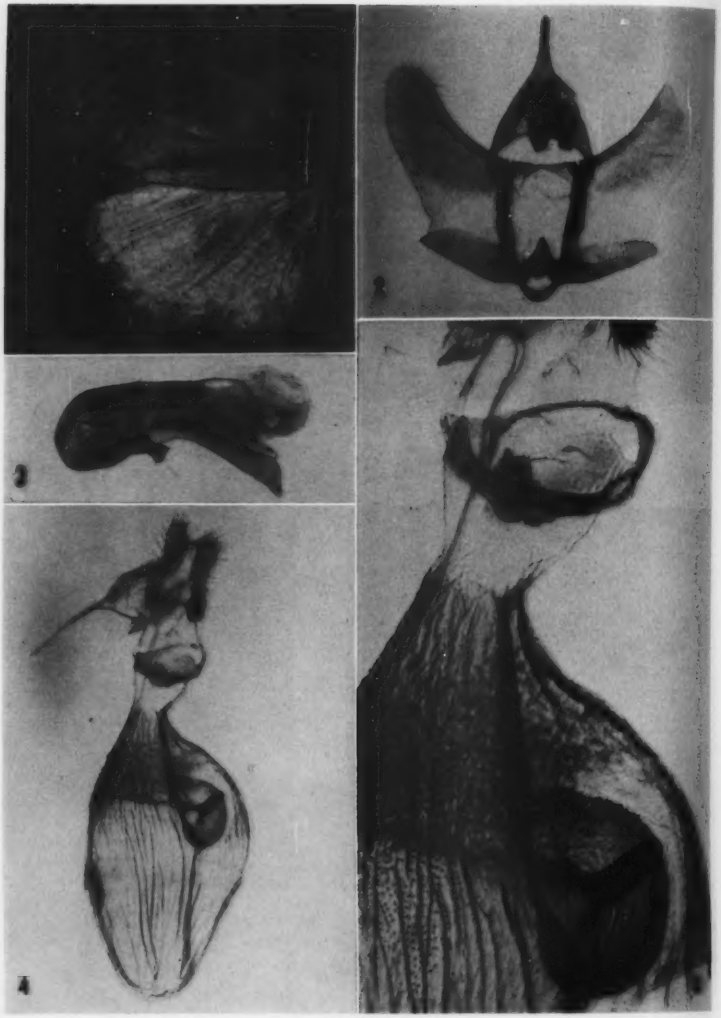


PLATE 4.—*Proculia aethalea*, new species. Holotype, male: 1, left wings; 2, ventral aspect of genitalia with aedeagus removed; 3, lateral aspect of aedeagus. Allotype, female, genitalia: 4, ventral aspect; 5, detail of bursa copulatrix.

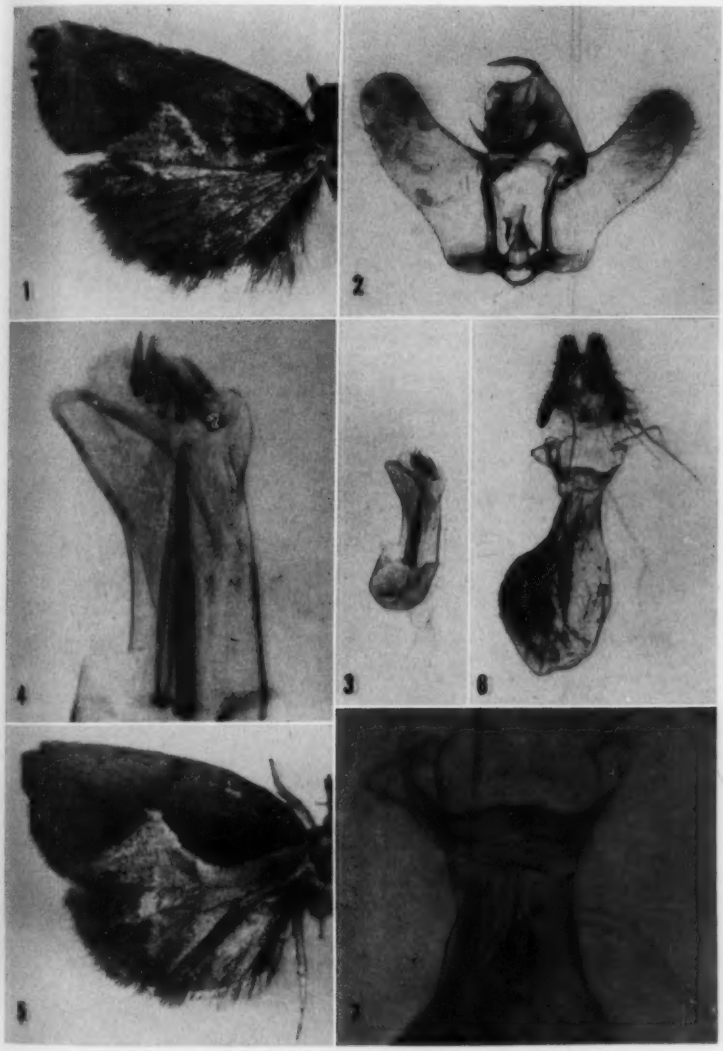


PLATE 5.—*Proeulia triquetra*, new species. Holotype, male: 1, left wings; 2, ventral aspect of genitalia with aedeagus removed; 3, lateral aspect of aedeagus; 4, detail of aedeagus. Allotype, female: 5, left wings; 6, ventral aspect of genitalia; 7, detail of bursa copulatrix.

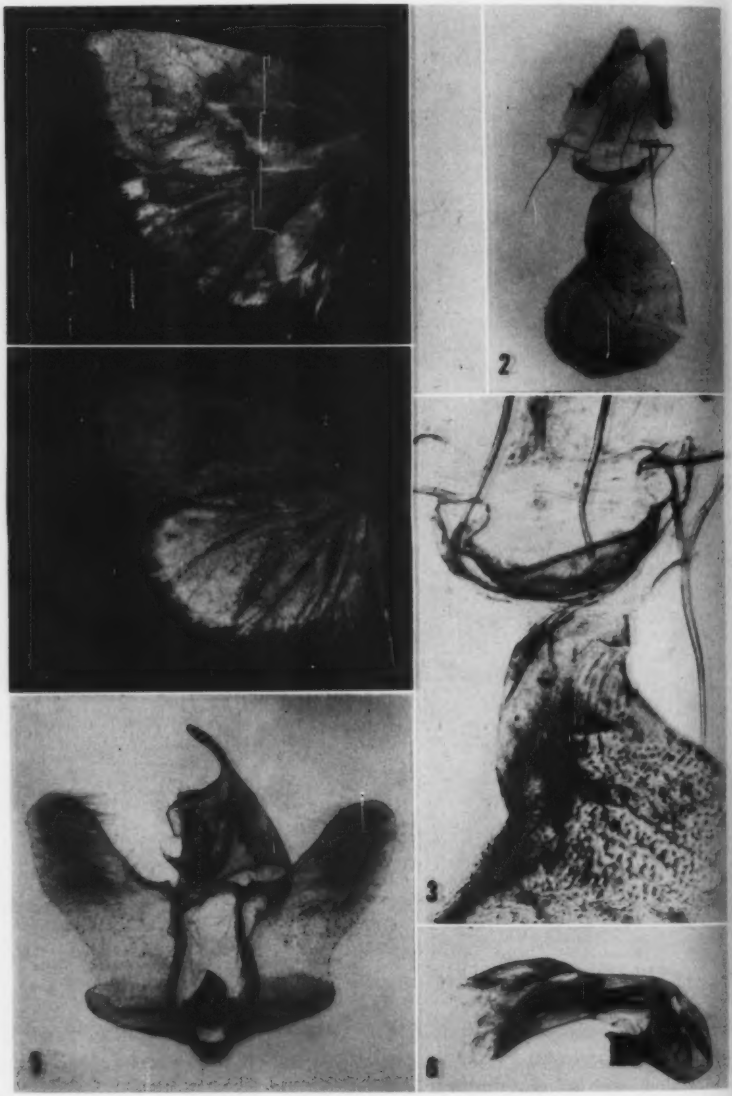


PLATE 6.—*Proeulia apospasta*, new species, holotype, female: 1, right wings (image reversed); 2, ventral aspect of genitalia; 3, detail of bursa copulatrix. *P. inconspicua*, new species, holotype, male: 4, left wings; 5, ventral aspect of genitalia with aedeagus removed; 6, lateral aspect of aedeagus.

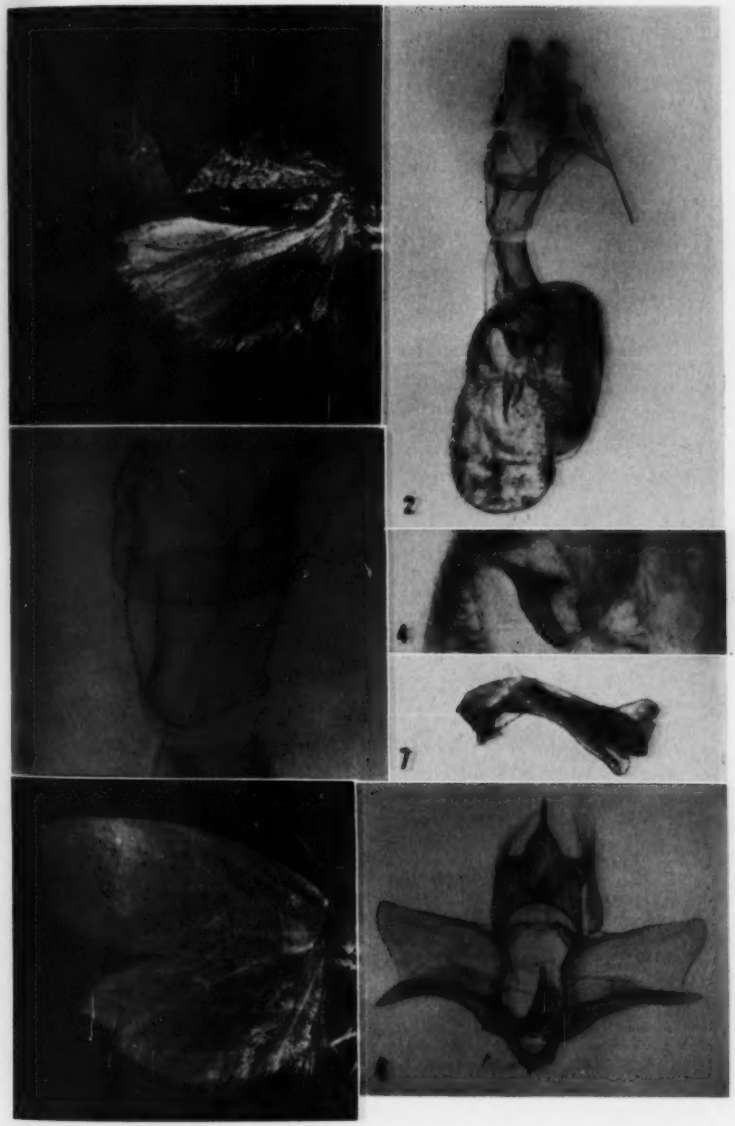


PLATE 7.—*Proculia tenontias* (Meyrick), female (genitalia on slide, 19-Obr., 1962): 1, left wings; 2, ventral aspect of genitalia; 3, detail of ostium bursae; 4, cestum. *P. cneca*, new species, holotype, male: 5, left wings; 6, ventral aspect of genitalia with aedeagus removed; 7, lateral aspect of aedeagus.

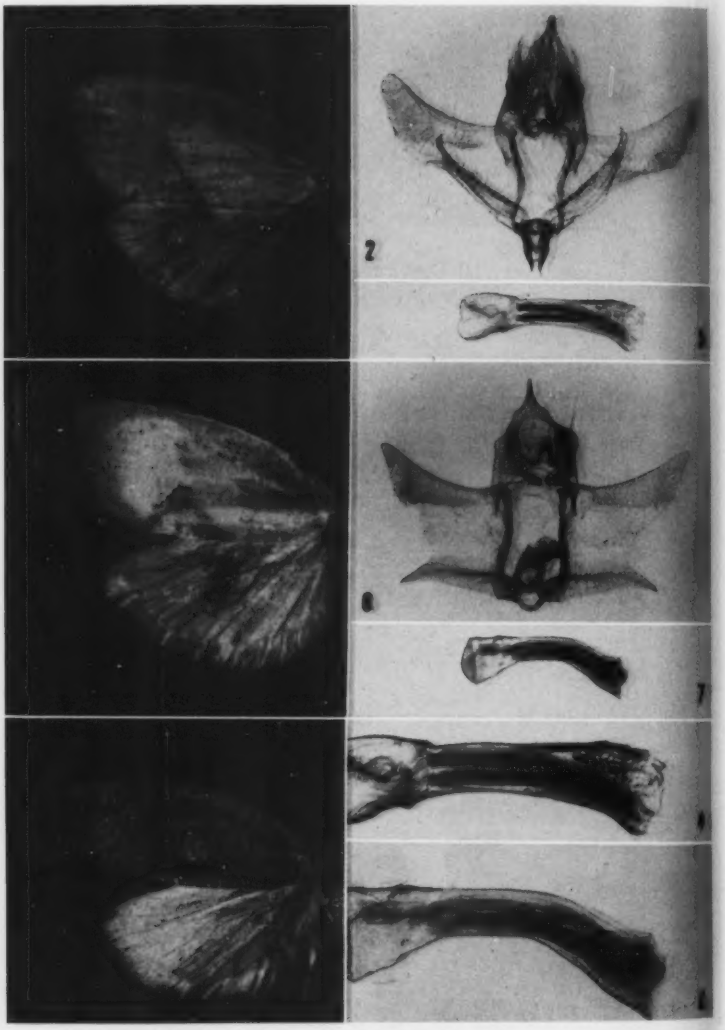


PLATE 8.—*Proeulia chrysopteris* (Butler), males. Holotype: 1, left wings; 2, ventral aspect of genitalia with aedeagus removed; 3, lateral aspect of aedeagus; 4, detail of aedeagus. Specimen from Chile Centro-Austral (genitalia on slide, 11-Obr., 1962): 5, left wings; 6, ventral aspect of genitalia with aedeagus removed; 7, lateral aspect of aedeagus; 8, detail of aedeagus. Specimen from Chile (genitalia on slide, 16-Obr., 1962): 9, right wings (image reversed).

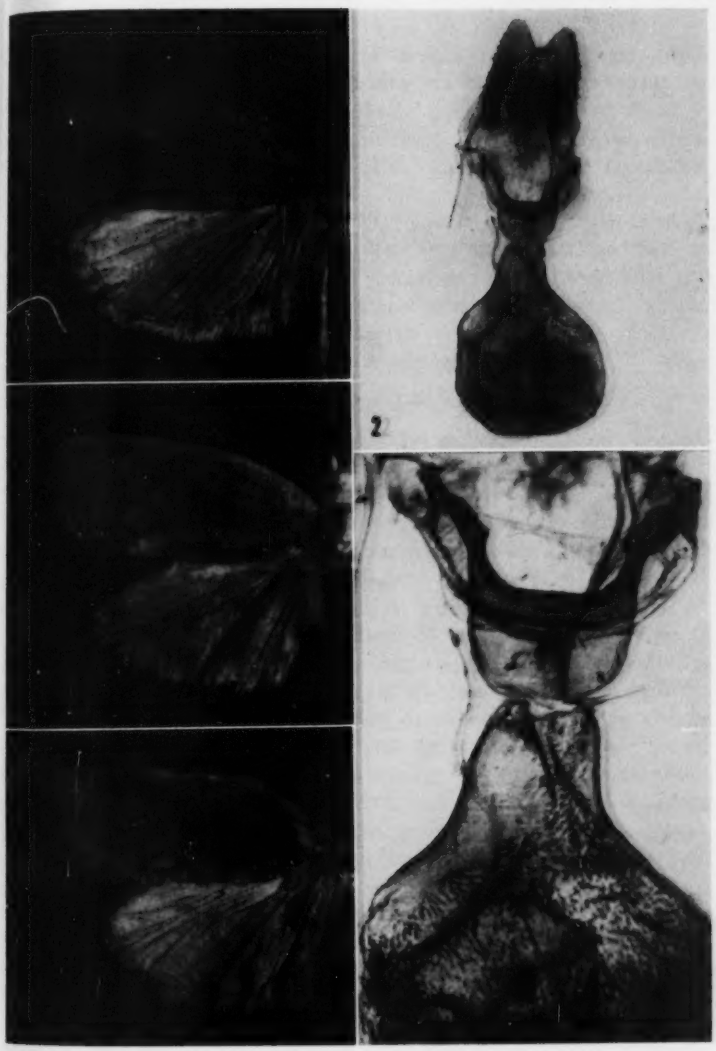


PLATE 9.—*Proeulia chrysopteris* (Butler), females. Specimen from Chile Centro-Austral (genitalia on slide, 13-Obr., 1962): 1, left wings; 2, ventral aspect of genitalia; 3, detail of bursa copulatrix. Specimen of Guayacán: 4, left wings. Specimen from Santiago: 5, right wings (image reversed).

externally. Aedeagus rather thick, with lower tip acute and upper with a slightly elevated carina; two long cornuti, one short, slightly longer than one-half length of long ones.

Type: Holotype, male (genitalia on slide, 3-Obr., 1962), La Obra, Santiago, Chile, October 1952 (L. E. Peña), USNM (type no. 66832).

Remarks: Somewhat similar to *Proeulia apospasta*, new species, but the markings of the forewing are more indistinct; no distinct triangular spot on the dorsum of forewing. Very typical of the species is a carina in the upper distal portion of the aedeagus.

***Proeulia apospasta*, new species**

PLATE 6 (FIGS. 1–3)

Female: Antenna ocherous, slightly brownish annulated. Labial palpus ocherous, mixed with ferruginous, paler from inside. Head, thorax, and abdomen concolorous with labial palpus. Legs pale ferruginous ocherous. Forewing ocherous, slightly ferruginous ocherous in external portion, and strongly so colored at wing base; a broad, ferruginous, longitudinal blotch, originating at wing base, tapering basad and externad, and not reaching end of discal cell; a narrow, oblique, brownish-ferruginous streak from lower angle of discal cell to middle of dorsum; a narrow, whitish line separating this streak from external, oblique edge of above-mentioned ferruginous blotch, and connected to pale ocherous, dorsal area below this blotch; a narrow, oblique, slightly undulate, brownish-ferruginous band shaded externally by ferruginous, running costotornad from about middle of costa but not reaching tornus, and with its middle touching upper end of above-mentioned brownish-ferruginous oblique streak almost under right angle; a triangular, pale ocherous dorsal spot separated by that streak and lower portion of mentioned costotornal band; some indistinct, pale ferruginous, minute streaks in costal area, and fine, concolorous dots and lines in area externad from costotornal band; a minute, brownish-ferruginous dot at dorsum before tornus; cilia pale ferruginous, becoming pale ocherous tornad; underside of forewing pale ferruginous, abruptly becoming darker before a pale ocherous, subterminal line. Length of forewing 10 mm. Hindwing light fuscous with slightly brassy hue; a concolorous tuft of hairs at base of veins A_2 and A_3; cilia whitish with a fine, greyish basal line.

Male: Unknown.

Female genitalia: Lamella antevaginalis band-shaped, narrowed laterally; lamella postvaginalis weakly sclerotized. No separate antrum. Corpus bursae rotundate-pyriform, in most of caudal por-

tion scobinate; cestum located in cervix portion and consisting of a very short, rotundate projection on a bilobate, sclerotized base; cervix bursae rather broad. Sclerotization around otsium oviductus well developed.

Type: Holotype, female (genitalia on slide, 18-Obr., 1962), Concepción, Chile, October 1902 (E. C. Reed), USNM (type no. 66833).

Remarks: Somewhat similar to *Proeulia chrysopteris* (Butler), but differing from it in some details of the markings of the forewing, especially in the presence of a ferruginous blotch in the basal portion of the wing, a whitish line basad from the brownish outline of the dorsal triangular spot, and in having the hindwing unicolorous. The genitalic differences of *P. apospasta* consist of a flat sinus vaginalis, absence of the antrum, and especially of a bilobate base of the cestum, known only in this *Proeulia* species. The name of the species is derived from the Greek *αποσπαστος*, meaning "separated."

***Proeulia tenontias* (Meyrick), new combination**

PLATE 7 (FIGS. 1–4)

Cnephasia tenontias Meyrick, 1912, Trans. Ent. Soc. London, 1911, p. 685; 1912, *in* Wagner, Lepidopterorum catalogus, pt. 10, p. 49; 1913, *in* Wytsman, Genera insectorum, fasc. 149, p. 47.—Clarke, 1955, Catalogue of the type specimens of Microlepidoptera in the British Museum described by Edward Meyrick, vol. 1, p. 304.

Eulia tenontias, Clarke, 1958, Catalogue of the type specimens of Microlepidoptera in the British Museum described by Edward Meyrick, vol. 3, p. 139, pl. 69, figs. 4–4b.

Male genitalia: Uncus moderately long; socii short. Fultura superior moderately broad; fultura inferior rather low. Valva with apex directed straight upward; its external margin vertical, in lower portion slightly incurved; sacculus narrow, long, free pointed. Aedeagus moderately thickened, slightly bent; four inequally sized cornuti.

Female genitalia: Lamella antevaginalis band shaped with lateral portions directed caudad and outlining ostium bursae like a bracket; lamella postvaginalis membranous, not defined. Antrum large, subrectangular. Corpus bursae irregularly subovate; scobination occupying most of surface; cestum shaped as a digitate, slightly curved projection on a broad, swollen base; cervix bursae tubular, distinctly narrower than corpus bursae.

Type: Holotype, male (genitalia on slide, 6344, J.F.G.C.), Chile ("R. .05"); deposited in the British Museum (Natural History).

Other specimens examined: Two females, Chile (V. Izquerdo); one female (genitalia on slide, 19-Obr., 1962), Chile Centro-Austral, January–March 1898 (V. Izquerdo); one female (genitalia on slide,

20-Obr., 1962), Quilpué, Valparaiso, Chile, November 1897 (V. Izquerdo); all specimens are deposited in USNM.

Remarks: This species has hitherto been known as a unique male specimen. The holotype of *P. tenontias* and its genitalia were figured by Clarke (1958). The female specimens examined by the present author are very similar to the holotype, and there is no doubt that they are conspecific with it.

***Proeulia cneca*, new species**

PLATE 7 (FIGS. 5–7)

Male: Antenna grayish ocherous, in basal portion with a slight ferruginous tinge. Labial palpus brownish gray, on outer surface; separate scales dark gray basally, and whitish ocherous at tips; inner surface white ocherous. Head concolorous with outer surface of labial palpus, differing in color of separate scales, brownish gray at their middles, and whitish ocherous basally and at tips. Thorax brown with some scales long, orange ocherous; tegula orange ocherous. Abdomen slightly paler than thorax. Legs ocherous. Forewing ocherous with slight silvery shine and some areas covered with yellow scales especially dense in basal third of wing, along discal cell, costal and dorsal portions, and on external veins; minute, blackish dots on disc and in external wing portion; cilia pale ocherous, here and there slightly ferruginous, especially at tornus; underside of forewing ferruginous ocherous, whitish ocherous externally and dorsally. Length of forewing 11 mm. Hindwing white; basal tuft of hairs white.

Female: Unknown.

Male genitalia: Uncus rather long; socii long, almost equally broad. Fultura superior very narrow at middle, dilated and strongly sclerotized laterally; fultura inferior high. Valva elongate, not turned upward; its external margin rather short; sacculus long with a pointed tip protruding far beyond valva. Aedeagus moderately thickened, with tip rotundate; one rather thick and long cornutus with infundibuliform envelope at base.

Type: Holotype, male (genitalia on slide, 23-Obr., 1962), Guayacán, Santiago, Chile, 1100 m., October 1952 (L. E. Peña), USNM (type no. 66834).

Remarks: This species is very similar to *Proeulia leonina* (Butler) and differs from it in having no black dots on the discocellulars of the forewing and in having the hindwing shiny white. The genitalia are distinct in the two species. The name of this species is derived from the Greek κνῆκος, meaning "pale yellow."

***Proculia chrysopteris* (Butler), new combination**

PLATES 8, 9

Tortrix chrysopteris Butler, 1883, Trans. Ent. Soc. London, p. 69.
Eulia chrysopteris, Meyrick, 1912, *in* Wagner, Lepidopterorum catalogus, pt. 10, p. 39; 1913, *in* Wytsman, Genera insectorum, fasc. 149, p. 39.

Originally described from a single male specimen, this species has become known as being widely distributed in Central Chile. It is rather variable, having the forewings ocherous, golden ocherous, testaceous, or hessian brown with a more or less intensive, ferruginous-ocherous reticulation and/or incomplete, oblique rows of blackish or grayish dots in the apical wing portion and occasionally basad from it. The upper basal angle of the forewing generally stands out as a triangle of a different color from the remaining wing surface and is gray or whitish, concolorous with the thorax. On the dorsum, slightly before tornus, there is a large, more or less distinct, white to grayish-yellow or brownish-yellow triangular spot rather broadly outlined by brown and checked by short, gray, or brownish streaks along the dorsum. A slight, ferruginous-ocherous line sometimes connects the apex of this triangle with the middle of costa. The length of the forewing is from 10 to 13 mm. Hindwing whitish yellow to ocherous, becoming gray basad in most specimens. The head is generally concolorous with the thorax.

Male genitalia: Uncus moderately long; socii long, equally broad. Fultura superior rather broad; fultura inferior high. Valva with apex directed upward; sacculus broad, sharp pointed at tip, protruding valva. Aedeagus moderately thickened; two or three long, variously thick cornuti; a minute, sclerotized plate in external portion of vesica.

Female genitalia: Lamella antevaginalis bracket shaped, with lateral portions directed caudad and bearing angulate prominences toward ostium bursae. Antrum large, semirotundate. Corpus bursae pyriform, densely scobinate; signum located close to its middle, rather small, situated on a swollen base; cervix bursae rather broad.

Type: Holotype, male (genitalia on slide 8587), Chile ("82–107"); deposited in the British Museum (Natural History).

Other specimens examined: One female, Chile (V. Izquerdo); one male and two females (genitalia on slides, 16-Obr., 13-Obr., and 14-Obr., 1962), Chile Centro-Austral, January-March 1898 (V. Izquerdo); in USNM. Two males (genitalia on slides 6695, 6698), Quillota, Valparaiso, Chile, 1886 (Paulson, 68011, 68012), in the British Museum (Natural History). One female, Santiago, Chile, June 1955, reared from apricot fruit (G. Olalquiaga); one female (genitalia on slide, 4-Obr., 1962), Guayacán, Santiago, 1100 m., Jan. 25, 1951 (L. E. Peña);

one male (genitalia on slide, 11-Obr., 1962), Concepción, Chile, October 1902 (E. C. Reed); in USNM. One male (genitalia on slide 6696), Talcahuano, Concepción, Chile, Feb. 20–March 5, 1884 (Walker, 3197); in the British Museum (Natural History). One male (genitalia on slide, 12-Obr., 1962), Araucania [Arauco], Chile, March 1, 1892 (V. Izquerdo), USNM. One male (genitalia on slide 6697), Valdivia, Chile, 1901 (A. von Lossberg); in the British Museum (Natural History). One female (genitalia on slide, 15-Obr., 1962), Petrohué, Llanquihué, Chile, March 11, 1959 (J. F. Gates Clarke), in USNM.

Remarks: On the slide of the genitalia of the holotype in the British Museum (Natural History), the valvae are folded and the sacculi turned inward, crossing the inner surface of the valvae. The folding of the lower margin of the valva causes a slight change of shape in the latter, and the apex of the valva becomes less acute as demonstrated by other specimens placed in the same position as the holotype. The extreme shapes of the genitalia (as illustrated on plate 8, figs. 2 and 6) do not represent structural differences but only indicate differences that result from the preparation of the genitalia. The number of the cornuti varies between two (in the holotype and on slide 6698) and three (on six additional slides).

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NEOTROPICAL MICROLEPIDOPTERA. VI

GENERA ORSOTRICHA MEYRICK AND PALINORSA MEYRICK (GELECHIIDAE, OECOPHORIDAE)

By J. F. GATES CLARKE

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NEOTROPICAL MICROLEPIDOPTERA, VI[1]

GENERA ORSOTRICHA MEYRICK AND PALINORSA MEYRICK (GELECHIIDAE, OECOPHORIDAE)

By J. F. Gates Clarke

The moths of the genera *Orsotricha* and *Palinorsa* have been confused in collections for fifty years. Only the study of their types, plus additional material, permits clarification of their relationships at this time.

Gelechiidae

Orsotricha Meyrick

Orsotricha Meyrick, 1914, Exotic Microlepidoptera, vol. 1, p. 269; 1922, *in* Wytsman, Genera insectorum, fasc. 180, p. 45.—Fletcher, 1929, Mem. Dept. Agric. India, Ent. Ser., vol. 11, p. 156.—Gaede, *in* Bryk, 1938, Lepidopterorum catalogus, part 88, p. 87.—Clarke, 1963, Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 4, p. 341, pl. 167, figs. 1–1e.

[1] Prepared with the aid of a National Science Foundation Grant. Previous parts of this same series are: I and II, J. F. Gates Clarke, 1962, Proc. U.S. Nat. Mus., vol. 113, no. 3457, pp. 373–388; III, Clarke, 1964, ibid., vol. 115, no. 3480, pp. 61–84; IV, Duckworth, 1964, ibid., vol. 116, no. 3497, pp. 97–114; V, Obraztsov, 1964, ibid., vol. 116, no. 3502, pp. 183–196.

Meyrick proposed *Orsotricha* for *Topeutis venosa* Butler, from Chile, and subsequently associated with it *Pleurota literatella* Busck and *Orsotricha raptans* Meyrick, and placed the genus in the family Oecophoridae.

Butler's *Topeutis venosa*, the type of the genus *Orsotricha*, was described from a single female. Both the genitalia and the wing venation, particularly the crossvein between vein 8 and the cell of the hindwing, indicated at the time of the study of the Meyrick types that the species belonged in the Gelechiidae. Recent study of a male, the second specimen known, confirms this relationship and I hereby transfer *Orsotricha* to the Gelechiidae.

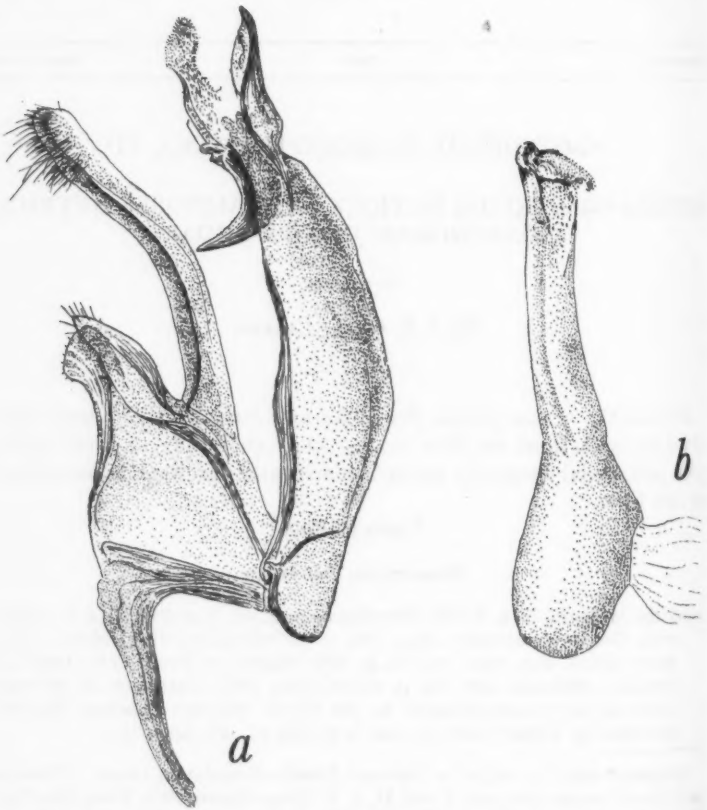


FIGURE 1.—*Orsotricha venosa* (Butler): *a*, lateral aspect of male genitalia with aedeagus removed; *b*, aedeagus.

***Orsotricha venosa* (Butler)**

FIGURE 1; PLATE 1 (FIG. 1)

Topeutis venosa Butler, 1883, Trans. Ent. Soc. London, 1883, p. 77.—Meyrick, 1914, Exotic Microlepidoptera, vol. 1, p. 269; 1922, *in* Wytsman, Genera insectorum, fasc. 180, p. 45.—Fletcher, 1929, Mem. Dept. Agric. India, Ent. Ser., vol. 11, p. 156.—Gaede, *in* Bryk, 1938, Lepidopterorum catalogus, part 88, p. 87.—Clarke, 1963, Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 4, p. 341, pl. 167, figs. 1–1e.

Type: British Museum (Natural History).

Distribution: Chile.

The genitalia of the male are here figured for the first time.

The two species previously associated with *O. venosa* belong to the family Oecophoridae and are treated below. Fortunately, a generic name is available for them.

Oecophoridae

Palinorsa Meyrick

Palinorsa Meyrick, 1924, Exotic Microlepidoptera, vol. 3, p. 99.—Fletcher, 1929, Mem. Dept. Agric. India, Ent. Ser., vol. 11, p. 159.—Gaede, *in* Bryk, 1938, Lepidopterorum catalogus, part 88, p. 87.

Meyrick proposed *Palinorsa* for *Pleurota literatella* Busck after he had assigned that species to *Orsotricha*. Despite the obvious close relationship between *P. literatella* and *O. raptans*, Meyrick left the latter species associated with *O. venosa* (Butler). I now include four species in *Palinorsa*.

Key to the Species of *Palinorsa*

1. Head brown or brownish 2
   Head ocherous white . . . . . **zonaria** Clarke, new species
2. Metathorax clothed with red hairlike scales 3
   Metathorax without red hairlike scales . . . . . **raptans** (Meyrick)
3. Forewing with conspicuous dark longitudinal streak. . . **literatella** (Busck)
   Forewing without conspicuous dark longitudinal streak.
   acritomorpha Clarke, new species

***Palinorsa literatella* (Busck)**

FIGURE 2

Pleurota literatella Busck, 1911, Proc. U.S. Nat. Mus., vol. 40, p. 205, pl. 8, fig. 12.
Palinorsa literatella (Busck), Meyrick, 1924, Exotic Microlepidoptera, vol. 3, p. 99.

Type: USNM.

Distribution: French Guiana, Rio Maroni.

Male genitalia: Harpe subtriangular; cucullus rounded with serrate ventral edge produced as a strong thornlike process; overlapping

the cucullar process a double-pointed, flattened, sclerotized plate, serrate on outer edge. Anellus composed of two irregularly shaped, curved plates fused at base and each with a small laterodistal lobe. Aedeagus short, stout, terminating in a beaklike process. Transtilla membranous, indicated by a few minute granules. Vinculum a broad sclerotized band. Gnathos an oval spined knob. Socii mainly indicated by setae. Uncus moderately hood-shaped, deeply incised on posterior margin.

Slide examined: ♂, JFGC 10948.

Female genitalia: Ostium irregular, broadest posteriorly, surrounded by a raised spiculate lip. Ductus bursae very short; inception of ductus seminalis dorsal and opposite center of ostial opening. Bursa copulatrix oval, without signum. Ovipositor lobes leathery, compressed. Anterior apophyses absent, or at most indicated only by a lateral thickening of genital plate.

Slide examined: ♀, JFGC 11198.

This is the first time that the genitalia of *P. literatella* have been figured, and the female is the first of any species of this genus that I have seen.

***Palinorsa raptans* (Meyrick), new combination**

Orsotricha raptans Meyrick, 1920, Exotic Microlepidoptera, vol. 2, p. 366.—Clarke, 1963, Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 4, p. 341, pl. 167, figs. 2–2b.

Type: British Museum (Natural History).

Distribution: Peru, Río Napo.

***Palinorsa zonaria*, new species**

FIGURE 3

Alar expanse 42 mm.

Labial palpus white; second segment with narrow fuscous line dorsobasally; third segment with slight apical infuscation. Antenna sordid white. Head ocherous white with ring of reddish-brown scales posteriorly. Thorax pale orange yellow shaded with reddish brown anteriorly; metathorax clothed with long, coral-red hairlike scales. Forewing pale orange yellow with brown median longitudinal streak: costa very narrowly edged with white; a pale spot on each side of vein 1c opposite base of vein 2; cilia pale orange yellow except at apex, the latter same color as median streak. Hindwing semihyaline; costal third and cilia ocherous white; at base a few coral-red hairlike scales and cilia. Legs ocherous white.

Male genitalia: Harpe broad; saccular and costal margins parallel, distally tapering to a blunt cucullus; middle heavily sclerotized giving rise to a strong thornlike clasper directed toward sacculus. Anellus

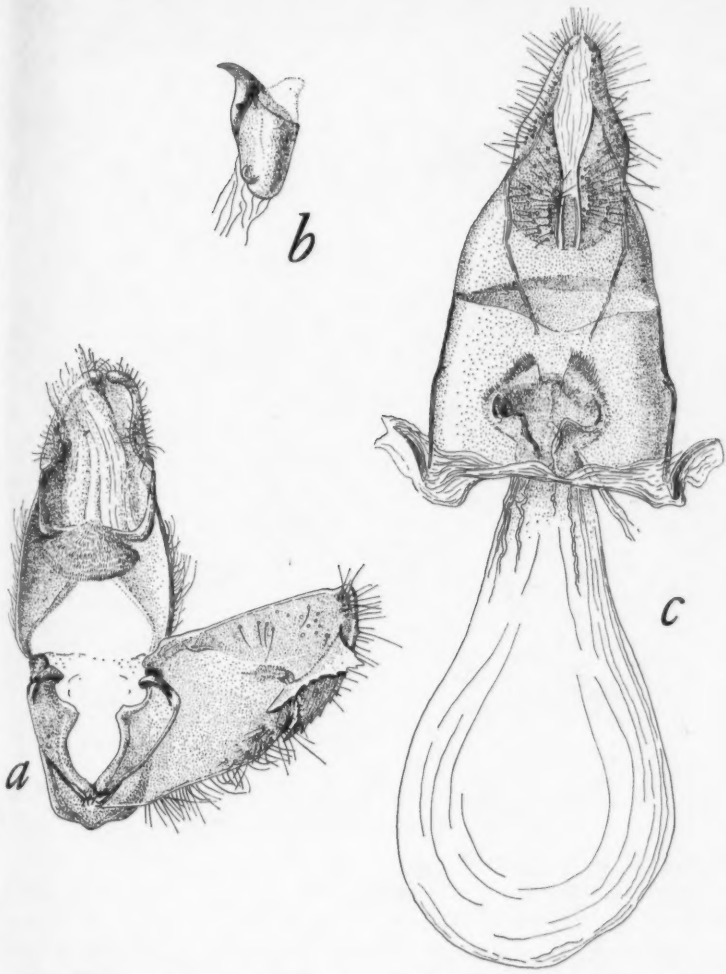


FIGURE 2.—*Palinorsa literatella* (Busck): *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

U-shaped with broad basal plate fused with base of harpe. Aedeagus short, stout, terminating in a broad hooked process articulating with anellus. Vinculum a narrow ring. Gnathos spined, U-shaped. Socii indicated by numerous setae. Uncus elongate, narrowly triangular, terminating in two points.

Slide examined: JFGC 11110.

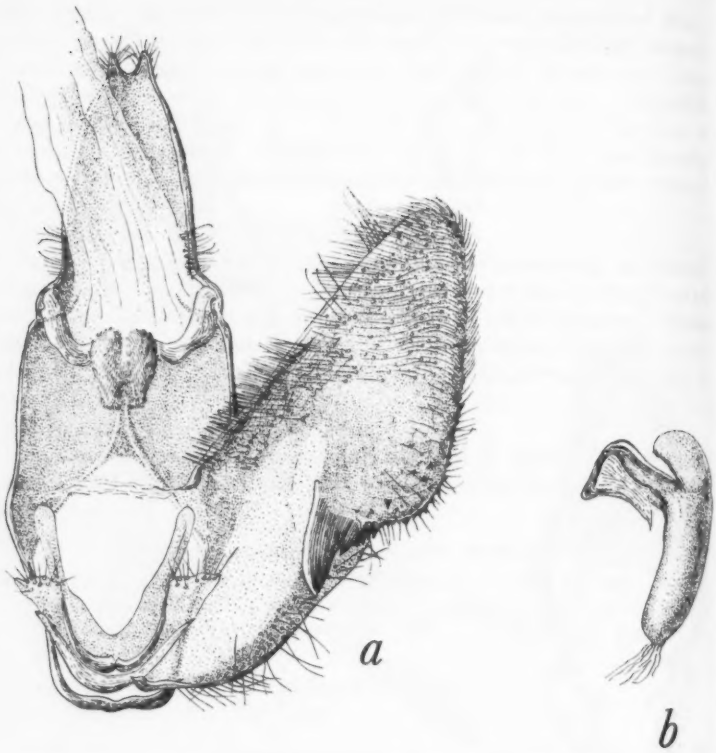


FIGURE 3.—*Palinorsa zonaria* Clarke, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus.

Female genitalia: Unknown.

Holotype: Bolivia(?), Monte Cristo (and an indecipherable word), Amazones. USNM 64993.

Described from the holotype male. Although there is only a single male with indefinite locality, it is so distinct it is worth description. The locality label leaves much to be desired. It is impossible to ascertain exactly where "Monte Cristo" is located but the "Amazones" suggests that the locality is actually in Bolivia. If it were possible to read the indecipherable part of the label, a more definite attribution might be made. In addition to the "Monte Cristo" label there is another in Busck's handwriting: "*Orsotricha raptans* Meyr.?"

All of the species of this genus are closely related but *zonaria* appears to be nearest to *literatella*. It is distinguished easily from the latter by its ocherous-white head.

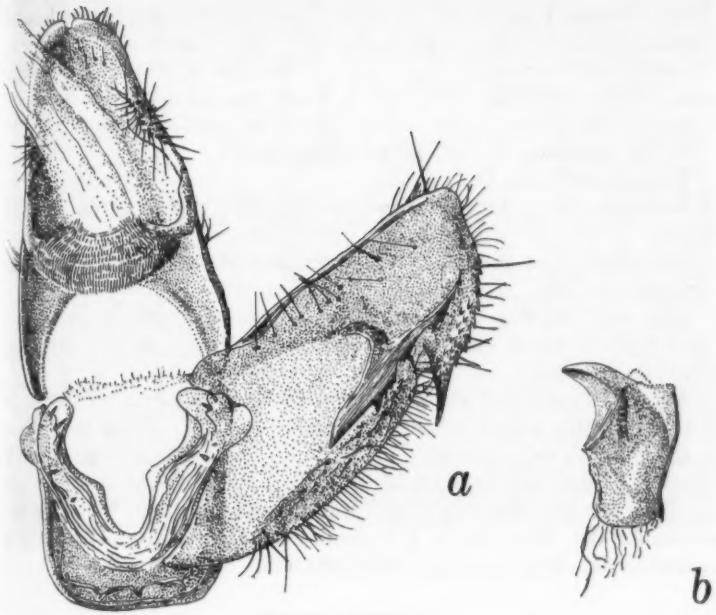


FIGURE 4.—*Palinorsa acritomorpha* Clarke, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus.

***Palinorsa acritomorpha*, new species**

FIGURE 4; PLATE 1 (FIG. 2)

Alar expanse 33–36 mm.

Labial palpus with second segment white ventrobasally, brown on outer side; on second segment a coral red median line on distal half on inner surface; third segment white. Antenna light brown. Head cinnamon; face white. Thorax cinnamon brown with a broad ocherous-buff median longitudinal band; metathorax clothed with long coral-red hairlike scales. Forewing cinnamon; extreme costa, before apex, whitish; in cell at one-third, a small fuscous spot; at end of cell an ill-defined transverse fuscous bar; on each side of vein 1c, opposite base of vein 2, a buff spot narrowly edged with fuscous; dorsum and termen narrowly fuscous; terminal cilia fuscous. Hindwing semihyaline whitish; cilia sordid white, except around base, coral red. Legs white shaded with cinnamon and fuscous. Abdomen roseate dorsally with median longitudinal row of confluent cinnamon spots.

Male genitalia: Harpe elongate ovate; cucullar edge serrate terminating in a long spinous process; from outer third a large spine

directed toward sacculus. Anellus V-shaped with prominent lateral lobes. Aedeagus short, stout, terminating in a beaklike process. Vinculum a broad sclerotized band. Transtilla indicated by sparsely setaceous membrane. Gnathos a finely spined oval knob. Socii indicated by a few setae. Uncus elongate, incised posteriorly.

Slides examined: 2 ♂ ♂, JFGC 10946, 11109.

Female genitalia: Unknown.

Holotype: Peru, Tingo Maria (Nov. 24, 1949, H. A. Allard). USNM 64992.

Described from the type male and one male paratype with identical data.

The two species *literatella* and *acritomorpha* are similar but *acritomorpha* lacks the dark longitudinal streak of the forewing found in *literatella*.

All of the species of *Palinorsa* are related closely and one wonders if one is dealing with a "cline" or incipient species. All males possess a short, stout aedeagus terminating in a beaklike process, and all specimens have a pair of small pale spots opposite the base of vein 2 of forewing. The genitalia appear to present substantial characters for the separation of the species, but the paucity of material is a serious handicap to proper interpretation.

Acknowledgments

The photographs for the paper were made by Mr. Jack Scott, staff photographer. The drawings were made by Mr. André Pizzini.

U.S. GOVERNMENT PRINTING OFFICE: 1964

FIGURE 1.—*Orsotricha venosa* (Butler): left wings.

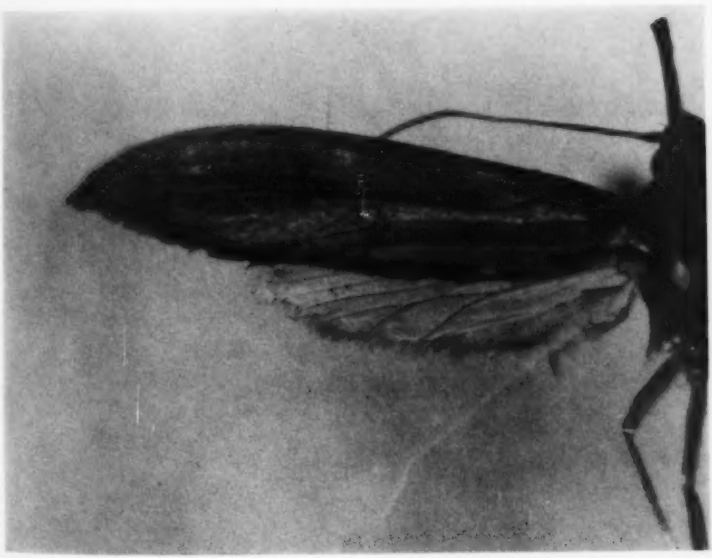
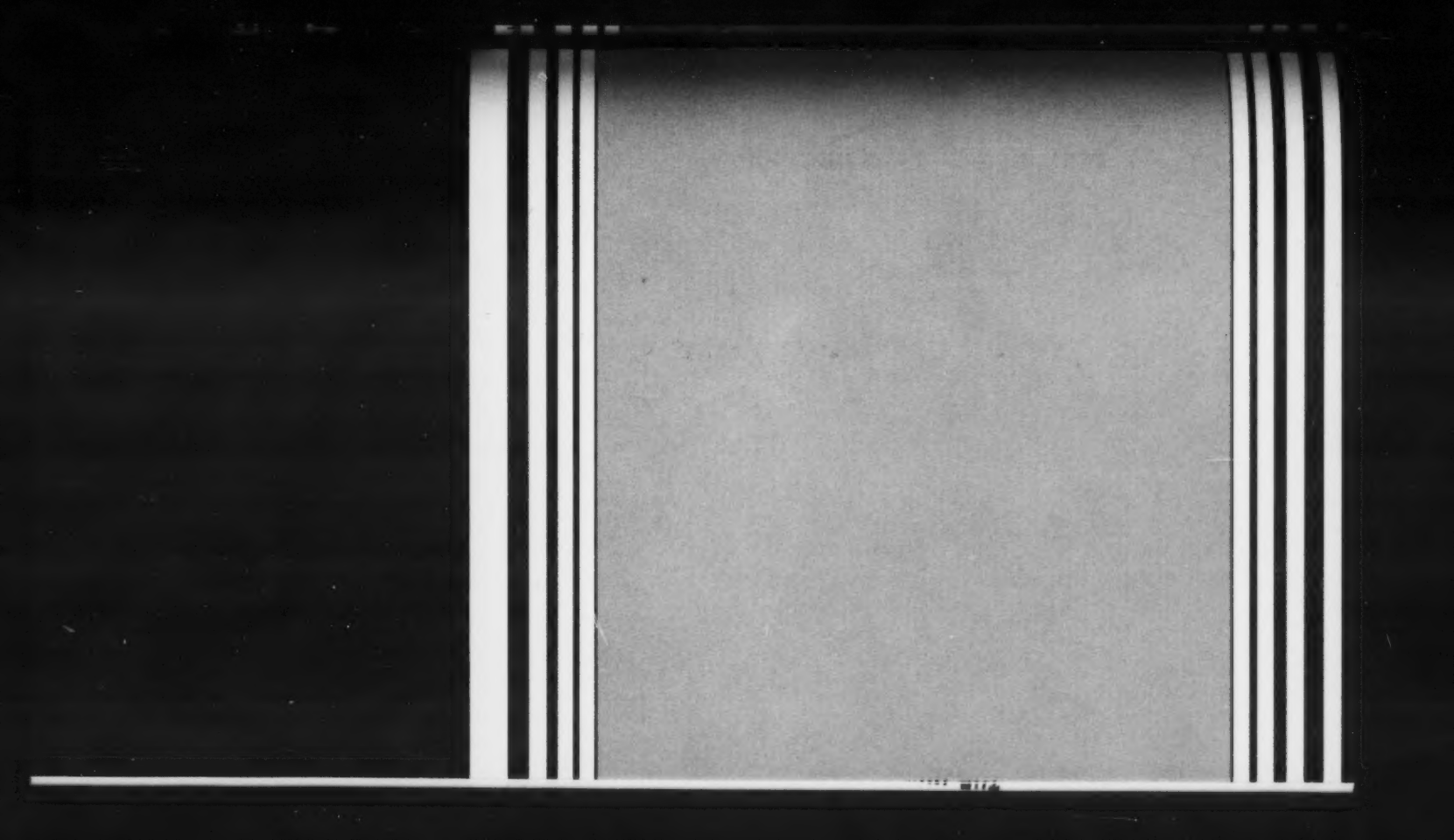


FIGURE 2.—*Palinorsa acritomorpha* Clarke, new species: left wings.



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CONTRIBUTIONS TO THE KNOWLEDGE OF THE HEMEROBIIDAE OF WESTERN NORTH AMERICA (NEUROPTERA)

By WARO NAKAHARA

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CONTRIBUTIONS TO THE KNOWLEDGE OF THE HEMEROBIIDAE OF WESTERN NORTH AMERICA (NEUROPTERA)

By WARO NAKAHARA

Introduction

Dr. Charles P. Alexander [A] amassed a fine collection of the Hemerobiidae during his sixteen entomological expeditions to various parts of western North America, and this, together with the additional material of nearly similar magnitude belonging to the United States National Museum [USNM], forms the basis of the present paper. Forty species recognized in the entire material are documented, including five species that are described as new and another species that also may be new but is left unnamed for the present.

The geographical area covered is west of the 100th meridian in the United States, British Columbia, Alberta, and Yukon in Canada, and Alaska. Localities by states and provinces not previously recorded are marked with asterisks. The reference to the original description is given for each species and genus; the complete synonymy is to be found in Carpenter (1940).

Carpenter recognized 50 species of the Hemerobiidae as occurring in the entire Nearctic region. Later, Gurney (1948) and Parfin (1956) each added two species, and Nakahara (1960), one more. The addi-

tions made by the present study bring the total of the named species to 60. It is notable that as many as 57 of this number are known to occur in the area defined above. Western North America is thus a veritable treasure house of the Hemerobiidae, and it seems likely that further exploration may bring to light more new species, especially of *Sympherobius*, which obviously is collected inadequately, and of *Kimminsia*, which seems exceptionally rich in the area.

My cordial thanks are due to Dr. Charles P. Alexander and Dr. Marion E. Smith for their kindness in submitting the Alexander collection to me for study. The major part of this collection has been returned to the Entomological Department, University of Massachusetts, Amherst, Mass., except the type specimens, which have been sent to the United States National Museum at the suggestion of Dr. Alexander. The examination of the United States National Museum material was made possible through the kindness of Dr. Oliver S. Flint, Jr., and Dr. Ashley B. Gurney, to whom I wish to express my sincere appreciation. The whole of this material has been returned to the Museum.

Family Hemerobiidae

Subfamily Hemerobiinae [1]

Genus *Sympherobius* Banks

Sympherobius Banks, Proc. Ent. Soc. Washington, vol. 6, p. 209, 1904.

The material before me contains ten species of this genus, including two that are new, while the following six species previously recorded are missing: *S. umbratus* Banks, *S. arizonicus* Banks, *S. pictus* (Banks), *S. limbus* Carpenter, *S. similis* Carpenter, and *S. distinctus* Carpenter. Most of these six species are known only from a unique type or at most from a few specimens.

Sympherobius californicus Banks

Sympherobius californicus Banks, Trans. Amer. Ent. Soc., vol. 37, p. 346, 1911.

California: Alameda Co., Marin Co., San Jose, Benicia [USNM].
*Oregon: in Blue Mts. [USNM].

Sympherobius bifasciatus Banks

Sympherobius bifasciatus Banks, Trans. Amer. Ent. Soc., vol. 37, p. 347, 1911.

*Utah: Logan [USNM].

[1] According to my studies on genitalic characters (1960), the family Hemerobiidae is divisible into two subfamilies, Hemerobiinae and Notiobiellinae, with all the Nearctic genera belonging to the former subfamily.

***Sympherobius angustus* (Banks)**

Hemerobius angustus Banks, Trans. Amer. Ent. Soc., vol. 30, p. 102, 1904.

*Nevada: Mt. Charleston near Las Vegas [A]. *California: Yosemite Park [A]. Washington: Mt. Rainier [A]. Utah: Logan [USNM]. Colorado: Cheyenne Canyon [USNM]; Bierstadt Lake in Rocky Mountain National Park [A]. New Mexico: Las Vegas [USNM].

The head of this species was described by Carpenter as "dark brown, almost black." In many specimens, especially of small size, it is much lighter, often yellowish, with a large dark patch on frons below the antennae. I have dissected the male genitalia of a few specimens with the yellowish head and satisfied myself that they are not separable from *S. angustus*.

***Sympherobius stangei* Nakahara**

Sympherobius stangei Nakahara, Mushi, vol. 34, p. 16, 1960.

*Colorado: Nymph Lake, Rocky Mountain National Park, 1 female [A].

The specimen completely agrees with the unique type of *S. stangei*, except that it is slightly smaller (length of forewing 6 mm. against 7 mm. in the latter). The original description is quoted here for the benefit of those to whom it may not be easily accessible:

Head yellowish brown, clypeus darker, palpi fuscous black, antennae fuscous black with paler basal joint. Forewing rather narrow, but much less so than in *angustus*, and fully rounded apically. Membrane colorless, broadly fuscous black along apical to outer margin; all veins behind R_1, except basal part of Cu_2, distal part of first anal and basal half of second anal, broadly marked with fuscous black; cells thus strongly marked out are clear-colorless, not containing any spot. Hindwing less strongly margined with fuscous, veins dark but unmarked.

Two branches to Rs in forewing, with radial crossvein between R_{4+5} and R_1 before the origin of R_{2+3}; first fork of Cu_1 distal to crossvein m-cu.

Length of forewing, 7 mm; width 2.5 mm.

Holotype: specimen lacking abdomen, Barton Flats, San Bernardino Co., California, July 22, 1953 (Lionel A. Stange).

This is a large and beautifully marked species, perhaps related to *occidentalis* (Fitch). The striking markings and venational characters of forewing alone may be sufficient for the recognition of this new species.

***Sympherobius brunneus*, new species**

FIGURE 1; PLATE 1 (FIGURE 1)

Holotype ♂, Miami Ranger Station (elevation 5000 ft.), Mariposa Co., Calif., July 5, 1945. Paratopotype ♂, July 1, 1954. Both collected by H. P. Chandler. Right forewing (dry) and dissected parts of genitalia (in balsam) of holotype mounted on two slides. Paratopotype is without left forewing; terminal abdominal segments in glycerol in small vial on the same pin. USNM type 66174.

Face yellow, vertex slightly brownish; palpi dark brown; antennae dark brown with yellow first joint. Pronotum yellow medially, narrowly brown on sides; meso- and matanotum yellow with light-brown scuta. Legs pale yellow. Abdomen light brown.

Forewing elongate oval with rounded apex, 5 mm. in length and 2 mm. in width; costal area narrow; membrane nearly uniformly tinted with brown, without maculation; venation dark brown, longitudinal veins sparsely streaked with hyaline. A short radial crossvein before origin of R_{2+3}; inner gradates disjointed in middle, the

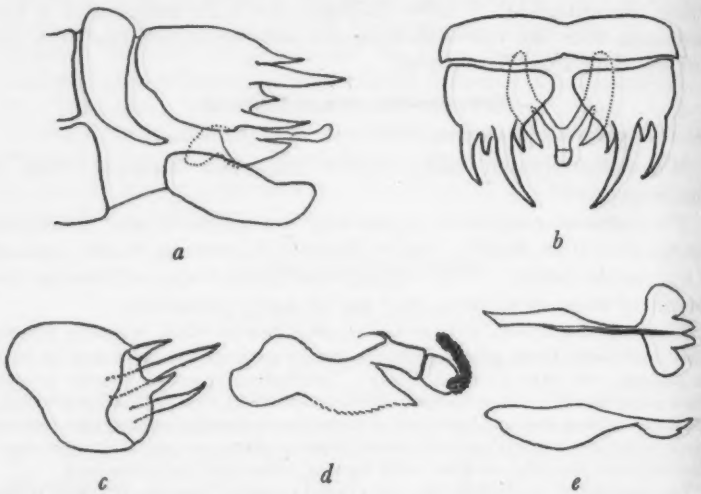

FIGURE 1.—*Sympherobius brunneus*, new species: *a*, terminal abdominal segments, lateral view; *b*, the same, dorsal views; *c*, anal plate, internal lateral views; *d*, tenth sternite, lateral and slightly dorsal view; *e*, parameres, dorsal (above) and lateral view (below).

upper two and lower two each on a straight line; Cu_1 forked beyond crossvein m-cu. Hindwing membrane hyaline, tinted with brownish only in costal area, especially in pterostigmatic region.

Male genitalia: Anal plate with four distal processes, resembling those of *S. angustus*, the first process from top (in lateral view) fairly long, the second the longest and most stout, the third the shortest, and the fourth the second longest. Tenth sternite with very broad lateral "wing," which in lateral view appears roughly triangular with pointed distal apex. Parameres with long fused part, distal lobes parted at apex, forming an acutely narrow median incision; lateral flaps broader anteriorly than posteriorly.

The brown-tinted membrane of forewing without maculation renders this species unique among the Nearctic *Sympherobius*. In order to include this species, Carpenter's key may be modified by introducing a new couplet 1′ after couplet 1 (forewing with radial crossvein):

1′. Forewing membrane practically uniformly tinted with brown, without markings . . . . . **S. brunneus**
Forewing membrane with brown or grey markings . Carpenter's couplet 2

***Sympherobius barberi* (Banks)**

Hemerobius barberi Banks, Proc. Ent. Soc. Washington, vol. 5, p. 241, 1903.

Arizona: Williams, paratype no. 6798 [USNM]. Utah: Provo [USNM]. Texas: Kerrville and San Antonio [USNM].

***Sympherobius perparvus* (McLachlan)**

Hemerobius perparvus McLachlan, Ent. Monthly Mag., vol. 6, p. 22, 1869.

*Utah: Tooele Co. [USNM]. California: Redding and Red Bluff [USNM]. Texas: Kerrville and Rankin [USNM].

***Sympherobius beameri* Gurney**

Sympherobius beameri Gurney, Ann. Ent. Soc. Amer., vol. 41, p. 220, 1948.

California: Rosamond, paratype no. 58600 [USNM].

***Sympherobius killingtoni* Carpenter**

Sympherobius killingtoni Carpenter, Proc. Amer. Acad. Arts Sci., vol. 74, p. 238, 1940.

Arizona: Williams [USNM]. New Mexico: Las Vegas, paratype no. 55224 [USNM].

***Sympherobius texanus*, new species**

FIGURE 2; PLATE 1 (FIGURE 2)

Holotype ♂: Kerrville, Texas, May 1954. Allotopotype ♀, and 1 paratopotype (without abdomen): June 1954. All collected by L. J. Bottimer. Right forewing (dry) and dissected parts of genitalia (in balsam) of holotype mounted on two slides. USNM type 66175.

Face yellow, vertex somewhat more brownish. Antennae brown, darker toward apex. Pronotum pale brownish, with faint indication of yellowish median streak; meso- and metanotum yellow, with a large brownish patch on each side of metanotum. Abdomen yellowish, darker toward apex.

Forewing slender, 3 mm. in length, 1.25 mm. in width, but broadly rounded beyond middle, and hindmargin nearly straight, not curved out at the region of cubital forks; costal area very narrow. Membrane predominantly pale brown because of the more or less diffuse macula-

tions, without any distinct blotch; venation pale brown, only outer gradates slightly and inner gradates strongly marked with brown, the latter forming the only conspicuous marking; apical and outer margins very narrowly dark brown with many pale interruptions. Radial crossvein absent.

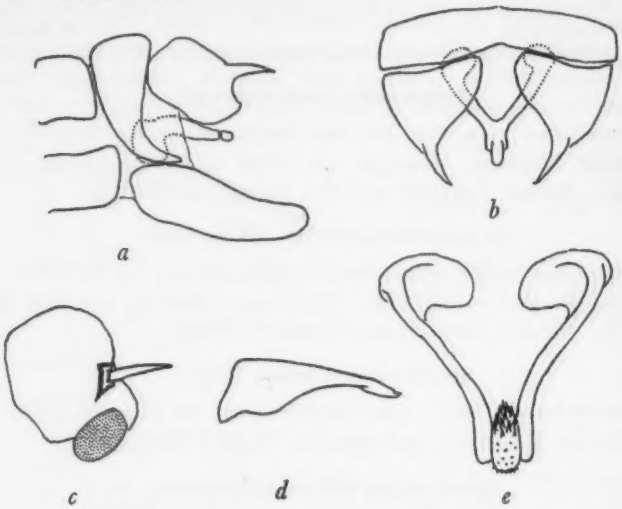

FIGURE 2.—*Sympherobius texanus*, new species: *a*, terminal abdominal segments, lateral view; *b*, the same, dorsal view; *c*, anal plate, internal-lateral view; *d*, parameres, lateral view; *e*, tenth sternite, dorsal view, with aedeagus bent posteriorly.

Male genitalia: Anal plate with ventroposterior angle slightly produced in lateral view; process single, fairly long, and straight. Tenth sternite with ventroproximal part of lateral "wing" expanded into a very large roundish flap. Parameres with the expanded distal part rounded on margin, without projecting middle arm.

This species will fit into a modification of couplet 9 (species without radial crossvein) in Carpenter's key:

9. Forewing membrane predominantly brown . . . . . 9'
Forewing membrane predominantly hyaline . to 10 of Carpenter's key
9'. Forewing narrowed toward apex and hindmargin rounded out; larger species: forewing 4.5 mm. long . . . . . **S. arizonicus** Banks
Forewing broadly rounded toward apex and hindmargin straight; smaller species: forewing 3 mm. long . . . **S. texanus**, new species

Texanus belongs to Gurney's "*perparvus* group," which is characterized by the anal plate of the male bearing a single process and which includes *S. perparvus*, *S. beameri*, and *S. killingtoni*. Of these the latter

may be the closest, but *S. texanus* can be distinguished readily by the very much smaller size and the brownish forewing without blotchy markings.

Genus *Pseudomicromus* Krüger

Pseudomicromus Krüger, Stettin Ent. Zeit., vol. 83, p. 172, 1922.

This genus, originally raised on the basis of ambiguous venational characters, has been reinstated by genitalic studies (Nakahara, 1960, p. 30). It is separated from other genera of the *Micromus* group by the paired aedeagus and by the absence of supraedeagal plate in the tenth sternite in the male. The material examined contained all the species that hitherto have been recorded.

Pseudomicromus angulatus (Stephens)

Hemerobius angulatus Stephens, Illustr. British Ins., vol. 6, p. 106, 1836.

South Dakota: Black Hills [A]. Colorado: Steamboat Springs [USNM].

Pseudomicromus variolosus (Hagen)

Micromus variolosus Hagen, Proc. Boston Soc. Nat. Hist., vol. 23, p. 284, 1886.

California: San Bernardino Mts. [A]. Colorado: Cheyenne Canyon [USNM]. Arizona: Chiricahua Mts. [A]; Tucson [USNM].

Pseudomicromus subanticus (Walker)

Hemerobius subanticus Walker, Neuropt. British Mus., pt. 2, p. 282, 1853.

California: Redding [USNM]. Arizona: Chiricahua Mts. [A]. Texas: Brownsville [USNM].

Genus *Stenomicromus* Krüger

Stenomicromus Krüger, Stettin Ent. Zeit., vol. 83, p. 171, 1922.

The dorsally spine-beset single aedeagus and the huge distal process of the anal plate are diagnostic of this genus. Parameres are separated, connected with each other only by a short bridge near base. The genus consists of the genotype, *S. paganus* of Europe, and its Nearctic counterpart, *S. montanus*.

Stenomicromus montanus (Hagen)

Micromus montanus Hagen, Proc. Boston Soc. Nat. Hist., vol. 23, p. 279, 1886.

Alberta: Waterton Lakes National Park [A]. British Columbia: Alaska Highway [A]. Washington: Olympic National Park, Mt. Rainier, and Mt. St. Helena [A]. *Oregon: Wallowa Mts. and Willamette National Forest [A]. Colorado: Dream Lake and Glacier Creek in Rocky Mt. National Park, Gothic [A]. California: Castle Crags [A].

Genus *Ameromicromus* Nakahara

Ameromicromus Nakahara, Mushi, vol. 34, p. 33, 1960.

This genus is endemic in North America, consisting of a single species, *A. posticus*. It is well characterized by the presence of a large subquadrate supraedeagal plate in the tenth sternite, which covers the aedeagus dorsally like a hood, and by the completely fused parameres, the apical two-thirds of which is in the form of a long pointed process and the basal one-third, in that of a thin blade (Nakahara, 1960, p. 33). Krüger's *Paramicromus* is a homonym.

Ameromicromus posticus (Walker)

Hemerobius posticus Walker, Neuropt. British Mus., pt. 2, p. 283, 1853.

*Washington: St. Andrews Creek, 3800 ft., Mt. Rainier, July 17, 1953, a single male [A].

Genus *Hemerobius* Linnaeus

Hemerobius Linnaeus, Systema naturae, ed. 10, vol. 1, p. 549, 1758.

All but two (*H. nigrans* and *H. alpestris*) of the previously recorded species of this genus are represented. There is an additional species in the USNM collection that I am unable to identify.

Hemerobius humulinus Linnaeus

Hemerobius humulinus Linnaeus, Systema naturae, ed. 10, vol. 1, p. 550, 1758.

*Alaska: Teller [USNM]. *Washington: Mt. Hood and Merritt [A]. This common Holarctic species, previously recorded from British Columbia, seems to be very rare in western North America.

Hemerobius pacificus Banks

Hemerobius pacificus Banks, Trans. American Ent. Soc., vol. 24, p. 24, 1897.

British Columbia: Wellington [USNM]. California: Kings Canyon National Park [A]; Mill Valley, Van Damme State Park, Inverness, Berkeley, Carmel, and San Jacinto Mts. [USNM]. Utah: Plain City and Logan [USNM]. Arizona: White Mts. and Chiricahua Mts. [A]. New Mexico: Frijoles Canyon in Bandelier National Monument.

In spite of the great difficulty in distinguishing the female of *H. pacificus* from that of *H. neadelphus*, I referred all the specimens to the former, which show accentuated asymmetry of the apical part of forewing with more pointed apex.

Hemerobius neadelphus Gurney

Hemerobius neadelphus Gurney, Ann. Ent. Soc. America, vol. 41, p. 214, 1948.

British Columbia: Nanaimo and Wellington [USNM]. *Washington: Mt. St. Helena, Olympic National Park, and Mt. Rainier [A]. Oregon: Blue Mts. [A]. California: Lost Creek in Lassen National Park, Hatchet Pass near Burney, King's Canyon National Park, and

Sequoia National Park [A]; Mill Valley [USNM]. *Montana: Gallatin City [A]. *Colorado: Bierstadt Lake in Rocky Mountain National Park [A]. *Nevada: Washoe Co., and Kyle Canyon on Mt. Charleston [A]. *Arizona: Chiricahua Mts. [A].

There are over 50 females from various British Columbia, Alberta, California, Oregon, Utah, Wyoming, North Dakota, and Arizona localities that possibly may belong to this species but which I have not been able definitely to distinguish from *H. pacificus*. As Gurney (1948) stated, there seems to be no dependable differential feature in the female between the two species. On the whole, the forewing seems to be slightly more rounded at apex in *H. neadelphus* than in *H. pacificus*.

Hemerobius simulans Walker

Hemerobius simulans Walker, Neuropt. British Mus., pt. 2, p. 285, 1853.

Alaska: Teklanika River in Mt. McKinley Park [A]. British Columbia: Alaska Highway and Kootenay National Park [A]; Wellington [USNM]. *Oregon: Rogue River National Forest, Langdon Lake in Blue Mts., and Mt. Hood [A]. *California: Castle Lake [USNM]. *Montana: Avalanche Lake in Glacier National Park [A]. *Wyoming: Grand Teton National Park [A]. *Colorado: Clear Creek in Clear Creek Co.

Hemerobius ovalis Carpenter

Hemerobius ovalis Carpenter, Proc. Amer. Acad. Arts Sci., vol. 74, p. 205, 1940.

Alaska: Mt. McKinley National Park [A]. Washington: Mt. St. Helena [A]. Oregon: Rogue River National Forest [A]. California: Lassen National Park [A]. Wyoming: Yellowstone National Park [A]. *Colorado: Bear Lake in Rocky Mountain National Park and Gothic [A].

Hemerobius stigmaterus Fitch

Hemerobius stigmaterus Fitch, Noxious Ins. New York, reports 1 and 2, p. 93, 1856.

Alberta: Waterton Lake National Park [A]. Washington: Cle Elum [USNM]. Oregon: Bend, Lostine Valley in Wallowa Mts., Blue Mts., and Rogue River National Forest [A]. California: Yosemite National Park, Tioga Pass in Tuolumne Co., Nordon, and Lake Tahoe [A]; Fort Bragg, Miami Ranger Sta., Smith River, Castle Lake, San Jacinto Mts., Truckee, Keddie, and Nevada City [USNM]. *Montana: Glacier National Park [A]. Idaho: Twin Creek Camp in Salmon National Forest [A]. Wyoming: Teton Co. [USNM]. Colorado: Fraser [USNM]; Nymph Lake in Rocky Mountain National Park [A]. New Mexico: Chiricahua Mts. [USNM].

In a recent publication Tjeder (1960) synonymized *H. stigmaterus* under *H. stigma* Stephens, believing that the slight deviation in the shape of the median process of the tenth sternite (gonarcus) to be of

no specific value. He did not mention the difference in aedeagus, which to me seems rather important: *H. stigma* does not show the toothlike lateral expansion near the base that is present in *H. stigmaterus* (see Gurney, 1948, fig. 10, and Nakahara, 1960, fig. 96). The intraspecific range of variability in these structures has not been explored adequately, however, and further studies involving dissection of a large number of specimens seems necessary in establishing this possible synonymy.

Hemerobius conjunctus Fitch

Hemerobius conjunctus Fitch, Noxious Ins. New York, reports 1 and 2, p. 94, 1856.

Alaska: Mt. McKinley Park [A]. *Yukon: Alaska Highway [A]. Alberta: Banff National Park [A]; Mt. St. Piran [USNM]. *Washington: Olympic National Park and Mt. St. Helena [A]. *Oregon: Blue Mountains, Crater Lake, and Wallowa Mts. [A]. *California: Yosemite National Park [A]. *Idaho: Twin Creek Camp in Salmon National Forest [A]. Utah: Uinta Mts. and Cedar Breaks National Monument [A]. *S. Dakota: Black Hills [A]. Colorado: Rocky Mountains National Park, Gothic, Pike National Forest, and Arapaho National Forest [A].

Hemerobius kokaneeanus Currie

Hemerobius kokaneeanus Currie, Proc. Ent. Soc. Washington, vol. 6, p. 85, 1904.

*Alaska: Prince of Wales Is. [USNM]. *Alberta: Waterton Lake National Park [A]. Washington: Olympic National Park and Mt. Rainier [A]. *Oregon: Willamette National Forest and Mt. Hood [A]. *Wyoming: Teton Co. [USNM]. Colorado: Newcastle [USNM].

Hemerobius bistrigatus Currie

Hemerobius bistrigatus Currie, Proc. Ent. Soc. Washington, vol. 6, p. 79, 1904.

British Columbia: Wellington [USNM]. *Washington: Mt. Rainier [A]; Baring [USNM]. Oregon: Ochoco Mts. [A]. California: Lake Tahoe and Napa [USNM]. *Montana: Glacier National Park [A].

Hemerobius species

Alaska: Anchorage, one female [USNM].

Head, thorax, and abdominal tergites and sternites deep black, with a faint median light-colored streak on notum. Antennae dark brown; basal joint black. Forewing about 7 mm. in length; membrane uniformly greyish, unmarked except for a dark dot on crossvein m-cu, and a dark longitudinal streak in pterostigmatic region.

This may well be a new species.

Hemerobius dorsatus Banks

Hemerobius dorsatus Banks, Canadian Ent., vol. 36, p. 61, 1904.

Alaska: Alaska Highway [A]. *Yukon: Alaska Highway [A]. Alberta: Banff National Park and Jasper National Park [A]; Kannanaskis [USNM]. British Columbia: Alaska Highway [A]. *Oregon: Crater Lake [A]. *Montana: Beaverhead National Forest [A]. *California: Yosemite National Park and Inyo National Forest [A]. Colorado: Rocky Mountain National Park [A].

Genus *Brauerobius* Krüger

Brauerobius Krüger, Stettin Ent. Zeit., vol. 83, p. 171, 1922.

This genus is characterized by the exceedingly elongated anal plate of the male, which is rounded apically and bears no spinous projection (Nakahara, 1960, p. 50). Internal ventral margin of the plate is beset with numerous denticulate tubercles toward apex. It consists of three species: *G. marginatus* (Stephens), type species, *G. tristriatus* (Kuwayama), and *G. costalis* (Carpenter), the last being the sole Nearctic representative.

Brauerobius costalis (Carpenter)

Hemerobius costalis Carpenter, Proc. Amer. Acad. Arts Sci., vol. 74, p. 213, 1940.

Alaska: Fairbanks [USNM]. British Columbia: Yoho, Banff, and Waterton Lakes National Parks [A]. *Idaho: Boise National Forest [A].

Genus *Kimminsia* Killington

Kimminsia Killington, Monogr. British Neuropt., vol. 2, p. 254, 1937.

Eleven species of this genus are recognized in the material before me, and three of them are described as new. These three, though represented by a single specimen each, one unfortunately a female, are of such distinctive characters that I feel entirely safe in naming them. These were all collected by Dr. Alexander. There are three other species of this genus previously recorded from western North America but not found in the material: *K. fumata* Carpenter, *K. longipennis* (Banks), and *K. constricta* Parfin.

Kimminsia disjuncta (Banks)

Hemerobius disjuncta Banks, Trans. Amer. Ent. Soc., vol. 24, p. 25, 1897.

Alaska: Matanuska [USNM]. British Columbia: Kaslo [USNM].

Kimminsia coloradensis (Banks)

Hemerobius coloradensis Banks, Trans. Amer. Ent. Soc., vol. 24, p. 26, 1897.

Washington: Blue Mts. [USNM].

***Kimminsia involuta* Carpenter**

Kimminsia involuta Carpenter, Proc. Amer. Acad. Arts Sci., vol. 74, p. 219, 1940.

Alaska: Fairbanks [USNM]. British Columbia: Kokanee Mts. [USNM].

***Kimminsia brunnea* (Banks)**

Boriomyia brunnea Banks, Bull. Mus. Comp. Zool. Harvard, vol. 64, p. 333, 1920.

Alaska: Mt. McKinley Park [A]. Alberta: Jasper and Banff National Parks [A]. Colorado: Head of Elk Creek [USNM].

***Kimminsia pretiosa* (Banks)**

Boriomyia pretiosa Banks, Trans. Amer. Ent. Soc., vol. 34, p. 260, 1908.

Colorado: Clear Creek [USNM]. Utah: Uinta Canyon and Logan [USNM].

***Kimminsia schwarzi* (Banks)**

Hemerobius schwarzi Banks, Proc. Ent. Soc. Washington, vol. 5, p. 241, 1903.

*Alaska: Mt. McKinley Park [A]. California: Yosemite National Park [A]. Arizona: Williams [USNM].

***Kimminsia olympica*, new species**

FIGURE 3; PLATE 1 (FIGURE 3)

Holotype ♂, Deer Park (5400 ft.), Olympic National Park, Washington, July 17, 1948 (C. P. Alexander). Right forewing (dry) and

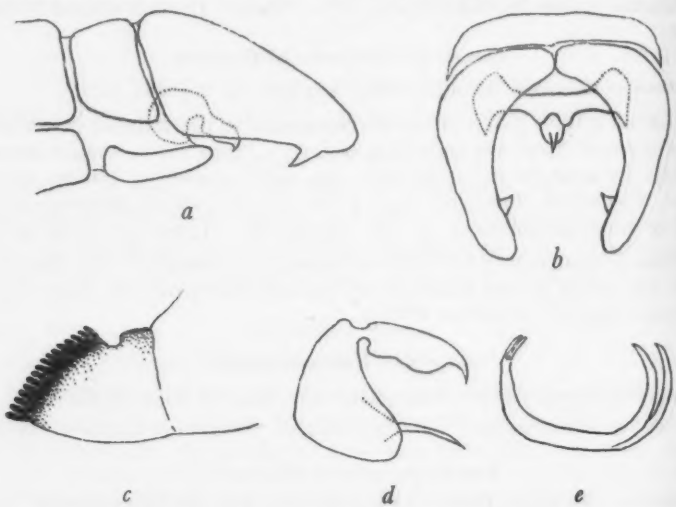

FIGURE 3.—*Kimminsia olympica* new species: *a*, terminal abdominal segments, lateral view; *b*, the same, dorsal view; *c*, apical comb of anal plate, internal view; *d*, tenth sternite, lateral view; *e*, parameres, lateral view.

dissected parts of genitalia (in balsam) mounted on two slides. USNM type 66176.

Face uniformly fuscous brown; vertex with two elongated pale patches divided by median fuscous brown longitudinal stripe; palpi and antennae brownish. Pronotum broadly brownish yellow medially, darker on sides. Mesonotum brownish yellow, fuscous brown on sides. Metanotum almost totally fuscous brown. Abdomen fuscous brown. Legs brownish yellow.

Forewing: Length 9.5 mm, width 3.5 mm, rather elongated with rounded apex; longitudinal veins pale with fuscous brown spots and short streaks; inner and outer gradates deeply fuscous and strongly margined with brown; basal crossveins m-cu and cu also fuscous and margined; membrane hyaline, with many small sagittate maculations in discal area; outer and hindmarginal area marked with scattered brownish patches; the markings forming a long brown fascia across the wing over inner gradates, one over the basal crossveins, a short one in hindmarginal area between the two, and a fourth, interrupted fascia over outer gradates. Hindwing hyaline; veins fuscous, except toward base, where they are pale.

Male genitalia: Anal plate long and slender, rounded apically, with a stout sharply pointed ventroapical process, which is bent strongly forward and somewhat inward. Tenth sternite rather narrow, dorsal bridge between "wings" short, narrowly produced posteriorly, bearing long and laterally compressed aedeagus over it; ventral process very long and slender. Parameres turned up at both ends, fused in middle; the separated basal parts short, and distal parts very much longer.

This species is like *Kimminsia fumata*, *K. constricta*, *K. pretiosa*, and *K. schwarzi* in having down-curved ventroapical process to anal plate, but the anal plate itself is much longer and more slender in this species, and the process is strongly bent forward and is sharply pointed. It is a rather conspicuous species with maculations roughly forming four transverse bands across the forewing.

Kimminsia posticata (Banks)

Boriomyia posticata Banks, Trans. Amer. Ent. Soc., vol. 32, p. 39, 1905.

*Yukon: Alaska Highway [A]. *California: Tuolumne Meadows in Yosemite National Park [A]. Utah: Logan [USNM].

Kimminsia alexanderi, new species

FIGURE 4; PLATE 1 (FIGURE 4)

Holotype ♂, Haines Highway, Alaska, July 5, 1952 (C. P. Alexander). Right forewing (dry) and dissected parts of genitalia (in balsam) mounted on two slides. USNM type 66177.

Face fuscous brown, with a narrow yellow transverse line along the

base of clypeus; vertex yellow; palpi brown; antennae brownish yellow, darker beyond middle. Pronotum brownish yellow, with fuscous-brown longitudinal stripe in middle and on sides; meso- and metanotum broadly yellowish medially, brownish on sides. Legs yellowish. Abdomen yellowish basally, brownish beyond middle.

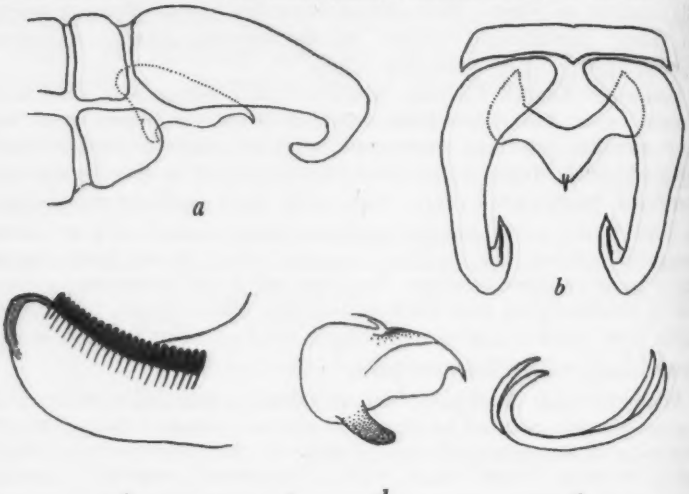

FIGURE 4.—*Kimminsia alexanderi*, new species: *a*, terminal abdominal segments, lateral view; *b*, the same, dorsal views; *c*, apical comb of anal plate, internal view; *d*, tenth sternite, lateral view; *e*, parameres, lateral view.

Forewing: Length 7 mm., width 3 mm.; apex rounded; membrane very slightly smoky, practically immaculate in discal area; outer marginal area down to the end of cubitus with alternate brownish and hyaline small patches; the patches larger in hindmarginal area from Cu_1 to hindmargin. A rather conspicuous dark-brown spot over the last crossvein of the inner gradate series. Longitudinal veins fuscous, interrupted with short pale streaks; crossveins of the same shade of fuscous. Hindwing slightly smoky with fuscous venation, which is paler toward base.

Male genitalia: Anal plate very long and narrow, distally curved roundly downward and then forward; apical part provided with a closely set series of short teeth on ventrolateral margin. Tenth sternite produced posteriorly into a large subtriangular lobe (in dorsal view), ending in a short pointed dorsoapical process; lateral "wings" broad, with a large lateroposterior process, which ends in inwardly curved obtuse apex. Parameres slender, strongly curved,

fused in middle and separated proximally and distally; the proximal lobes shorter than distal parts, all sharply pointed at ends.

The strongly curved ventroapical process of anal plate in this species reminds one of *K. posticata*, but anal plate is very much narrower in lateral view and the apical prolongation is only slightly more slender than the body of the plate. This species is very much smaller than *K. posticata*, and the forewing membrane is uniformly smoky in discal area, maculations being confined to postcubital area.

***Kimminsia furcata* (Banks)**

Boriomyia furcata Banks, Psyche, vol. 42, p. 55, 1935.

Alaska: Toklat River [USNM], Haines Highway, Mt. McKinley National Park, and Richardson Highway [A]. Alberta: Jasper National Park and Kicking Horse Pass [A]. *British Columbia: Alaska Highway [A]. *Washington: Olympic National Park [A]. California: Yosemite National Park, Tioga Pass in Tuolumne Co. [A]. *Nevada: Lake Tahoe [A]. Colorado: Timber Creek Camp, Chambers Lake, and Monarch Pass in Rocky Mt. National Park. [A].

***Kimminsia melaleuca*, new species**

PLATE 1 (FIGURE 5)

Holotype ♀, Alaska Highway, Mile Post 720, Yukon Territory, July 2, 1952 (C. P. Alexander). Right forewing mounted dry on a slide. USNM type 66178.

Face shining black, brownish toward anterior margin of clypeus; vertex dull black. Antennae fuscous, almost black. Pronotum black, narrowly margined with brownish yellow anteriorly, with two ill-defined brownish-yellow longitudinal stripes submedially. Mesonotum black, with two brownish-yellow patches lateroposteriorly, each enclosing a short black longitudinal streak. Metanotum and abdomen black. Legs brownish yellow, femur broadly banded with dark brown toward both ends.

Forewing: Length 7 mm., width 3 mm., apex rounded. Veins black, interrupted with numerous white spaces; both series of gradates deep black, strongly margined with fuscous black, especially the posterior crossveins of the inner series; sagittate maculations of discal area strongly developed and mostly transversely confluent; outer and hindmarginal areas, distal to outer gradates, and behind Cu_1 decorated with large patches of alternate black and hyaline white. Maculations faint in costal space. Hindwing very distinctly smoky, with fuscous black venation; crossveins in pterostigmatic area conspicuously white.

The forewing of this black-bodied species is very striking because of the hyaline spots that appear so white owing to the whiteness of the

parts of the veins enclosed, in strong contrast to the deeply fuscous-black markings.

An attempt has been made to accommodate the three new species described above in Carpenter's key (1940, p. 215) and its partial modification by Parfin (1956, pp. 207–208).

Key to the Nearctic Species of *Kimminsia*

1. Pronotum with a conspicuous median yellowish stripe, bordered laterally with dark brown 2
   Pronotum without such a median stripe 10
2. Upper part of frons very dark brown, lower part yellowish or light brown with very abrupt transition . . . . . **K. coloradensis** Banks
   Frons more uniformly dark brown, or, if the upper part is darker than the lower, the transition is very gradual 3
3. Forewing with blackish-brown spots at distal m-cu crossvein and from Cu_1 to hindmargin 4
   Forewing with maculations more evenly distributed 5
4. Forewing nearly uniformly smoky in discal area; small species (forewing 7 mm.) . . . . . **K. alexanderi,** new species
   Forewing with some sagittate maculations in discal area; larger species (forewing 10 mm.) . . . . . **K. posticata** Banks
5. Anal plate of male with a very long dorsal process. . . . **K. furcata** Banks
   Anal plate of male without dorsal process 6
6. Anal plate of male with very long and slender apical process that is terminally expanded . . . . . **K. subnebulosa** (Stephens)
   Anal plate of male with short apical process 7
7. Process of anal plate strongly bent forward . . . **K. olympica,** new species
   Process of anal plate directed more or less straight downward 8
8. Process of anal plate short and bent inward. . . . . **K. constricta** Parfin
   Process of anal plate moderately long, not bent inward 9
9. Large species (forewing averaging 11 mm.), costal area broad. **K. involuta** Carpenter
   Smaller species (forewing averaging 9 mm.), costal area of moderate breadth . . . . . **K. disjuncta** (Banks)
10. Face, vertex, and pronotum deep black . . . . **K. melaleuca,** new species
    Face, vertex, and pronotum yellowish or light brown 11
11. Face, vertex, and pronotum with scattered red specks. **K. longipennis** Banks
    Face, vertex, and pronotum not so marked 12
12. Forewing without maculation . . . . . **K. brunnea** Banks
    Forewing with conspicuous maculations 13
13. Forewing without distinct transverse bands . . . . . **K. pretiosa** Banks
    Forewing with distinct transverse bands. 14
14. Mesonotum with dark-brown anterior border . . . . . **K. schwarzi** Banks
    Mesonotum uniformly light brown . . . . . **K. fumata** Carpenter

Genus *Wesmaelius* Krüger

Wesmaelius Krüger, Stettin Ent. Zeit., vol. 82, p. 170, 1922.

There is a single Nearctic species of this genus.

***Wesmaelius longifrons* (Walker)**

Hemerobius longifrons Walker, Neuropt. British Mus., pt. 2, p. 291, 1853.

Oregon: Princess Creek Forest Camp on Odell Lake in Klamath Co. [A]. *Idaho: Twin Creek Camp in Salmon National Forest and Lolo National Forest [A]. *Montana: Glacier National Park [A]. Colorado: Cheyenne Mts. [USNM].

Genus *Megalomus* Rambur

Megalomus Rambur, Hist. Nat. Ins., Neuropt., p. 418, 1842.

Only one of the four Nearctic species of this genus is represented.

***Megalomus moestus* Banks**

Megalomus moestus Banks, Trans. Amer. Ent. Soc., vol. 22, p. 314, 1895.

Arizona: Chiricahua Mts. [A and USNM].

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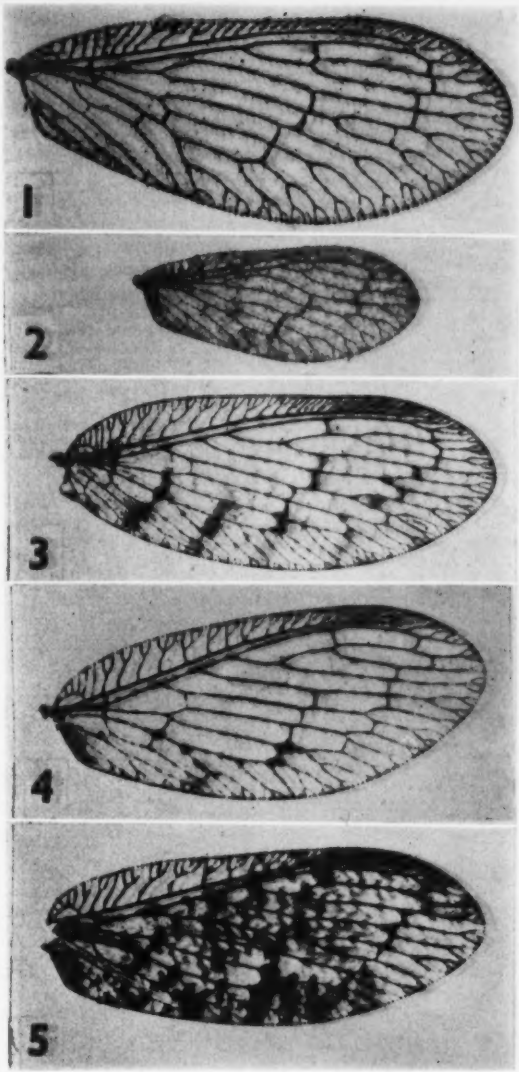
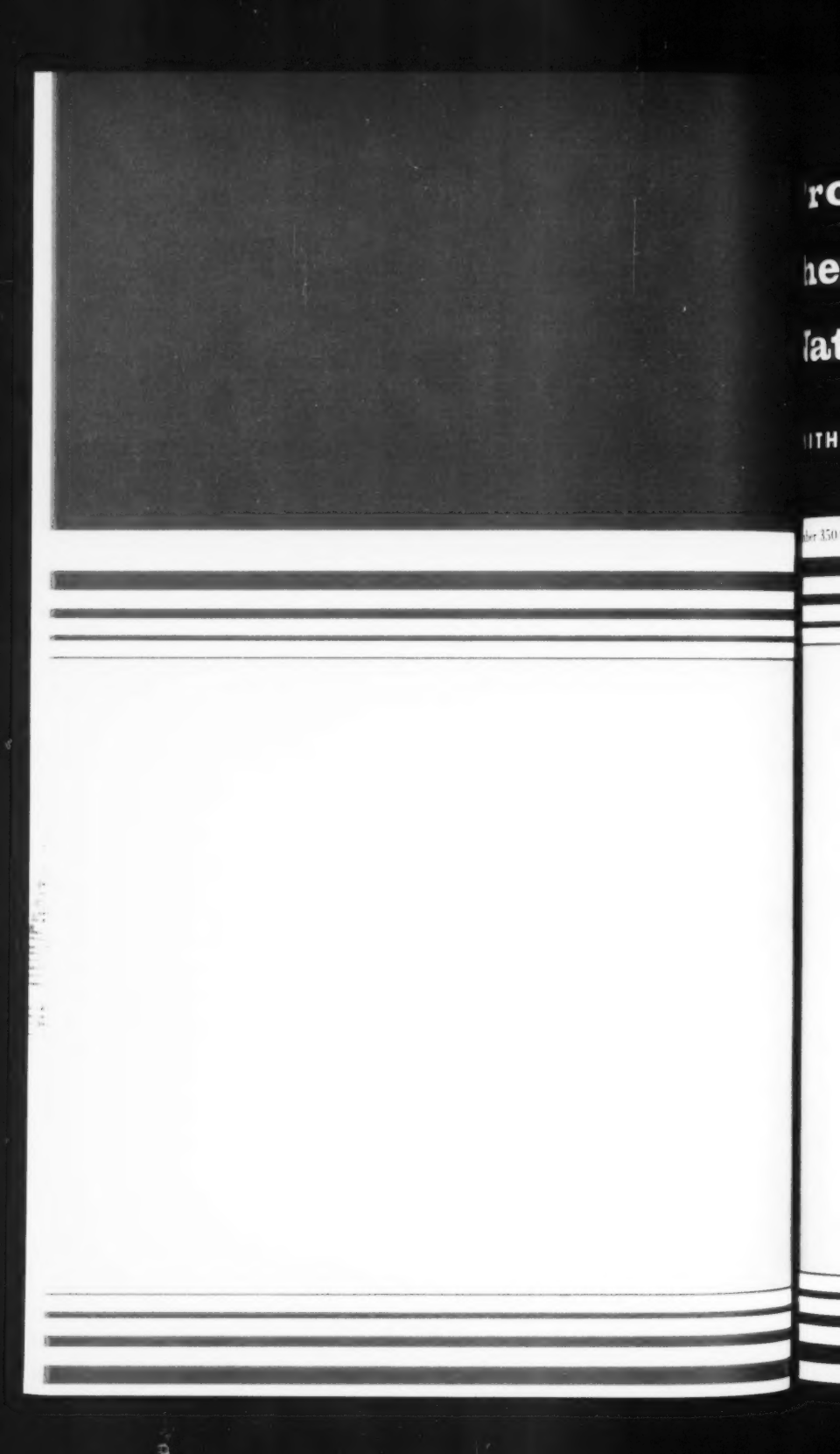


FOREWINGS.—1, *Sympherobius brunneus*, new species; 2, *Sympherobius texanus*, new species; 3, *Kimminsia olympica*, new species; 4, *Kimminsia alexanderi*, new species; 5, *Kimminsia melaleuca*, new species. (Relative sizes of wings not shown.)



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A CONTRIBUTION TO THE STUDY OF THE GENUS SPHAEROCERA LATREILLE IN CENTRAL AND SOUTH AMERICA (DIPTERA: SPHAEROCERIDAE)

By O. W. RICHARDS

Proceedings of
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A CONTRIBUTION TO THE STUDY OF THE GENUS SPHAEROCERA LATREILLE IN CENTRAL AND SOUTH AMERICA (DIPTERA: SPHAEROCERIDAE)

By O. W. Richards[1]

The latest revision of the American flies of the genus *Sphaerocera* Latreille (Malloch, 1925) records only one species of this genus from south of Panama: *S. flavicoxa* Malloch from Brazil and Costa Rica. Malloch records four species (*S. flaviceps* Malloch, *S. pallipes* Malloch, *S. bimaculata* Williston, and *S. varipes* Malloch) from Central America and the West Indies. Spuler erected a subgenus *Parasphaerocera* for *S. bimaculata* Williston that Malloch did not accept because it was founded principally on a color character to which two species, *S. annulicornis* Malloch and *S. pallipes* Malloch, though allied to the others, were an exception. In a re-examination of the genus, however, I find that there are four distinct groups, each with four or more species, and it is probably convenient to treat each group as a subgenus.

Key to Subgenera of *Sphaerocera* Latreille

1. Scutellum with, at most, one basal marginal tooth on each side. Mesoscutum with rows of minute bristles. Abdominal sternites nearly always more or less reduced, especially in female. Hindtibia with or without apical spur 2

[1] Department of Zoology and Applied Entomology, Imperial College, University of London, England.

Scutellum with six or more denticles along posterior margin. Mesoscutum with rows of warts. Abdominal sternites broad. Hindtibia with apicoventral spur. Face with central elevation that forms a sharp lower boundary to the antennal foveae 3

2. Face not elevated below, antennal foveae not sharply defined. Abdomen without dorsal pale spots . . . . Subgenus **Sphaerocera** Latreille 1804,

Type by subsequent monotypy, *Sphaerocera curvipes* Latreille, 1805. (Other species: *S. monilis* Haliday, 1836; *S. flaviceps* Malloch, 1925; *S. jeanneli* Richards 1938; *S. wittei* Vanschuytbroeck, 1948; *S. ruandana* Vanschuytbroeck, 1948; *S. longipes* Richards, 1951.)

Face elevated so that the antennal foveae are well defined below by a sharp keel. Abdomen usually with two large whitish spots.

Subgenus **Parasphaerocera** Spuler, 1924

Type by original designation, *Sphaerocera bimaculata* Williston, 1896. (Other species: *S. annulicornis* Malloch, 1913; *S. pallipes* Malloch, 1914; *S. flavicoxa* Malloch, 1925; *S. nigrifemur* Malloch, 1925; *S. varipes* Malloch, 1925; *S. striata* Malloch, 1925; *S. galapagensis* Curran, 1934; and the new species described below.)

3. Vein M_{1+2} and, to a less extent, R_{4+5} strongly bent forward. Mesoscutum uniformly covered with warts, longitudinal bare lines indistinct or absent.

Subgenus **Lotobia** Lioy, 1864

Type by monotypy, *Borborus pallidiventris* Meigen, 1830. (Other species: *Sphaerocera simia* Séguy, 1933; *S. arcuata* Séguy, 1933; *S. kivuensis* Vanschuytbroeck, 1948; *S. rutshuruensis* Vanschuytbroeck, 1948; and seven species described by Vanschuytbroeck in 1959.)

Veins M_{1+2} and R_{4+5} not bent forward. Mesoscutum with rows of warts and wide bare spaces in between some of the rows.

Subgenus **Ischiolepta** Lioy, 1864

Type by monotypy, *Borborus denticulatus* Meigen, 1830=*Sphaerocera nitida* Duda, 1923. (Other species: *Sphaerocera pusilla* (Fallén, 1820); *S. scabricula* Haliday, 1836; *S. vaporariorum* Haliday, 1836=*S. parapusilla* Duda, 1923; *S. orientalis* de Meijere, 1908; *S. scabra* Spuler, 1924; *S. jansseni* Vanschuytbroeck, 1948; *S. flava* Vanschuytbroeck, 1951; *S. dura* Vanschuytbroeck, 1959; *S. kifaruensis* Vanschuytbroeck, 1959; *S. crenata* (Meigen, 1838)=*S. coronata* (Zetterstedt, 1838); *S. paracrenata* Duda, 1923; *S. falcozi* Duda, 1921; *S. micropyga* Duda, 1923. The last four species form a separate subgroup.)

Subgenus *Parasphaerocera* Spuler, 1924

This subgenus appears to be exclusively American and it now appears that the species, though superficially similar to one another, are really very numerous. When I was in Berkeley in 1961, I was able to study a long series of males and females from one locality in Ecuador, a series that was preserved in the collection of the California Academy of Sciences (CAS). At first, the series seemed to consist of one species, but more careful study showed that there were three. In order to discover the relationship of these species with the supposedly common Central American species, *S. bimaculata* Williston, I borrowed all the specimens resembling that species in the collection of the U.S. National Museum (USNM). Through the kind help of Dr. J. F.

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Gates Clarke and Mr. Curtis Sabrosky, 27 specimens were sent to me. Careful study showed that 9 species were represented among a random distribution of males and females. Malloch first pointed out that the reduced sternites of this group provide specific characters. It seems that they provide by far the most important characters and require careful study in every form. Unfortunately, the type of reduction seems to be quite different in the two sexes, which are very difficult to associate. In some species the structure of the prosternum is a guide. The presence or absence of a minute anteroventral spur on the hindtibia is less useful than Malloch supposed because it may vary in size and, in some species, is difficult to detect. The nomenclature of the parts of the genitalia is the same as in Richards (1961). The new species described below are compared with *S. ecuadoria*, new species, rather than with *S. bimaculata* Williston because only in the former is a long series of both sexes available. Single specimens were examined of what appear to be six other species, but their characters are largely minor deviations from those of the species that are described.

New Species Allied to *Sphaerocera bimaculata* Williston

Sphaerocera (Parasphaerocera) ecuadoria, new species

Males and females. Black, dull, mesoscutum and pleuron only slightly more shining; antennae brown; mentum and palpi testaceous; legs pale yellow brown, tarsi and apices of femora slightly darker. Abdomen with two large pale spots. Halteres yellow. Wings hyaline, venation brown. Length 2.5–3.0 mm.

Lower face forming a flat trapeziform plate (fig. 7), coming up to a point between the antennae; area of lunula also raised into a flat triangular plate whose point meets that of the lower face at about the lowest point of the antennal attachment; antennal foveae thus sharply defined by a keel that is especially high internally and ventrally. Buccae not striate except rather indistinctly posteriorly. Arista four times as long as antenna with very short pubescence. Dorsum of head very dull, no proper bristles. Prosternum (fig. 6) in the form of a linear projection, about half as long as width of forecoxae, from the triangular depression in front of the mesosternum. Mesoscutum with some scaly tomentum and four indistinct rows of very short bristles (corresponding approximately to dorsocentrals and acrostichals), a few further, more lateral, bristles, irregularly placed. Scutellum with a small denticle on each side, where the hindmargin curves around to become transverse, dorsal surface almost bare. Legs thick, especially in the ♂, ♂ hindfemur twice as thick as midfemur. Hindtibia with a small black anterior apical spur, shorter than one-

quarter the apical width of tibia, spur smaller and paler in the female. Hindbasitarsus longer than the second segment but not as long as 2+3. Abdomen with tergal plates 1+2, 3, and 4, each slightly increasing in size; pale spots (fig. 1) caused by desclerotization of cuticle, lying across the boundaries between 1+2=3, and 3=4; anterior spot oval, posterior one pointed laterally, both well separated from the margin. Female with segments after 4 (figs. 2, 3) often retracted but tergite 5 sometimes visible as a narrow transverse plate; sternites (fig. 3) very reduced, 1+2 rather small and transverse, 3 somewhat longer than broad, weakly dumbbell shaped (or in the Chilcales specimen, diamond shaped), 4 very long and narrow, more than four times as long as broad, side margins sinuate; sternite 5 transversely crescentic; spiracles 1–4 in the membrane laterally (1 hard to see and very close to the thorax), 5 in the membrane between the fifth sternite[2] and tergite; cerci oval with short bristles. Male with tergite 5 relatively large, somewhat better developed on the right, tergites 6 and 7 visible on the left side; genitalia (figs. 4, 5) large; ninth segment not emarginate for the reception of the cerci and the anal orifice; cerci loosely attached to the ninth segment, emargination between them shallow, flat bottomed; gonapophyses absent, lateral lobes of forked plate short and broad, lying at the sides of the cerci; forceps long, narrow, pointed, curved upward, yellowish with rather long bristles on the inner sides; aedeagus with a basal stalk that expands distally and is angularly truncate, distally with an apical loop-like sclerite, each side of which is a lateral lobe; sternites 1+2 (fig. 4) represented by three small plates, the central one transverse and bigger than the other two; sternite 3 transverse with a moderately long and broad rounded posterior extension; sternite 4 very transverse, narrowed laterally; sternite 5 even more transverse with a central desclerotized area; sternites 3 and 4 with some longish bristles.

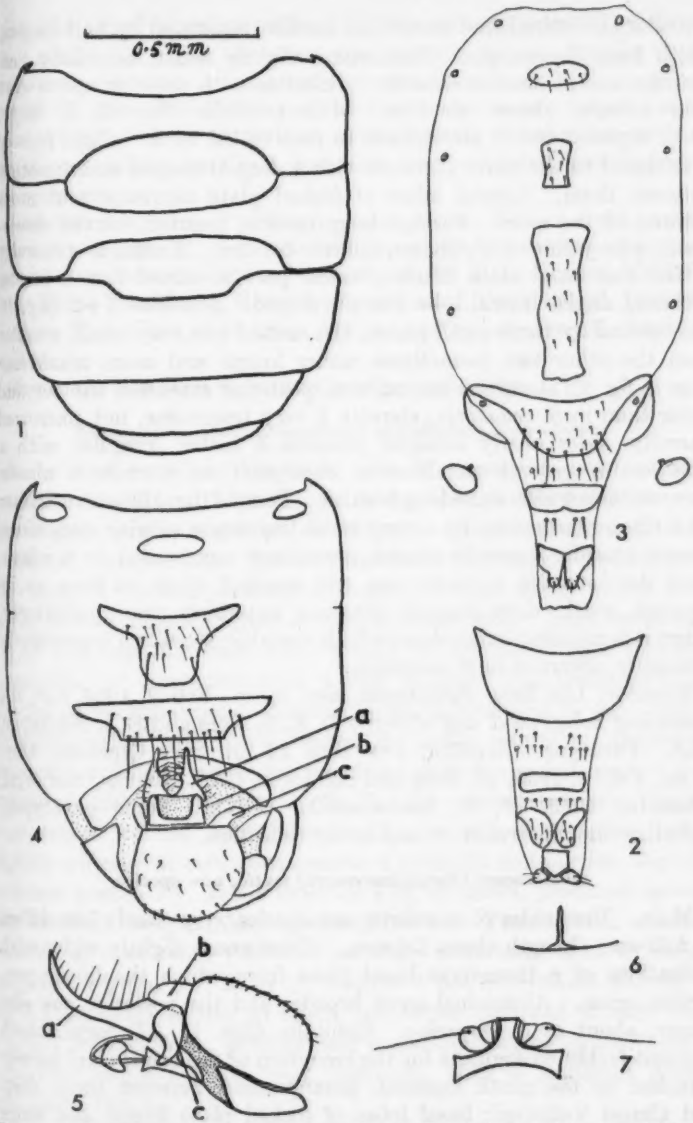
Ecuador: Los Rios, Pichilingue, elev. 40 m., Feb. 2, 1955, 20 ♂ 18 ♀ (including holotype ♂ and ♀ allotype), E. S. Ross and E. I. Schlinger, CAS; further paratypes, Guayas, Naranjal, December 1955, ♀, Chilcales, Aug. 1, 1955, ♀, R. Levi-Castillo, USNM.

Some paratypes in my collection, including 1 ♂, 1 ♀, macerated and in alcohol. The females and males are associated because they were the common type in the locality with the same type of prosternum.

***Sphaerocera (Parasphaerocera) trapezina*, new species**

Males and females. Resembles *S. ecuadoria*, new species, very closely but differs as follows: Size on the average slightly smaller.

[2] Young (1921, p. 260) found seven spiracles in *Copromyza* (=*Borborus*) *equina* Fall. I could find only five in *C. sordida* Zetterstedt, ♂.



FIGURES 1–7.—*Sphaerocera ecuadoria*, new species: 1, Dorsal view, ♂ abdomen. 2, Dorsal view, ♀ abdomen, tergite 5 to end extended. 3, Ventral view, ♀ abdomen, distal part extended, spermathecae drawn at sides. 4, Ventral view, ♂ abdomen: *a*, forceps; *b*, cerci; *c*, lateral lobe of forked plate. 5, Genitalia, ♂, from the right: *a*, forceps; *b*, cerci; *c*, lateral lobe of forked plate. 6, Prosternum, ♂. 7, Facial plate, ♂.

Anterior abdominal spot somewhat smaller, separated by half its own width from the margin. Prosternum slightly wider, especially posteriorly, and somewhat shorter. Hindtibia with anterior apical spur very minute, almost obsolete. Male genitalia (figs. 8, 9) large, ninth segment feebly emarginate to receive the cerci. Cerci loosely articulated to the ninth segment with a deep U-shaped emargination between them. Lateral lobes of forked plate narrower and more pointed at the apex. Forceps long, narrow, pointed, curved downward, pale yellow with denser, shorter bristles. Aedeagus generally similar but basal stalk blunter, apical part produced into a strong proximal angle, lateral lobe less developed. Sternites 1+2 (fig. 8) represented by three small plates, the central one very small, smaller than the other two (sometimes rather longer and more transverse than in fig. 8); sternite 3 trapeziform, posterior extension shorter and wider than in *S. ecuadoria;* sternite 4 very transverse, not narrowed laterally, sides nearly straight; sternite 5 rather irregular with a considerable central membranous emargination; sternite 3 almost bare, sternite 4 with some long bristles. Female (fig. 10) with sternites 1+2 often represented by a very small transverse sclerite, sometimes absent; sternite 3 usually absent, sometimes represented by a sclerotized dot; sternite 4 about two and one-half times as long as its greatest width, drop shaped, narrower anteriorly than posteriorly, where it is rounded, exact shape a little variable; sternite 5 transversely crescentic, about as in *S. ecuadoria.*

Ecuador: Los Rios, Pichilingue, elev. 40 m., Feb. 2, 1955, 5 ♂, 8 ♀ (including holotype ♂ and allotype ♀), E. S. Ross and E. I. Schlinger, CAS. Paratypes: Ecuador: Los Rios 27 mi. SW. Quevedo, elev. 50 m., Feb. 5, 1955, ♂, Ross and Schlinger, CAS; Guayas, Naranjal, December 1955, ♂, R. Levi-Castillo, USNM. Some paratypes, including one macerated ♂, are in my collection.

Sphaerocera (Parasphaerocera) tertia, new species

Male. Resembles *S. ecuadoria*, new species, very closely but differs as follows: Length about 2.6 mm. Prosternum slightly wider with indications of a transverse basal piece from which the linear projection arises. Abdominal spots broader and the posterior one also longer, about as *S. trapezina.* Genitalia (figs. 11, 12) large, ninth segment feebly emarginate for the reception of the cerci; cerci loosely attached to the ninth segment, emargination between them deep and almost V-shaped; basal lobes of forked plate longer and more pointed than in *S. ecuadoria*; forceps long, narrow, pointed, yellow, curved downward more strongly than in *S. trapezina*, with numerous setae; aedeagus with a short basal stalk bearing finger-shaped processes on each side, distally with a double lateral lobe on each side and

a looplike apical piece; sternites 1+2 (fig. 11) represented by three small plates, all about the same size, the central one usually very transverse; sternite 3 angularly dumbbell shaped but narrower posteriorly than anteriorly, the exact size and shape varying very little; sternite 4 very transverse, approximately rectangular, with a few short bristles; sternite 5 irregular, with a central membranous emargination.

Ecuador: Los Rios, Pichilingue, elev. 44 m., Feb. 2, 1955, holotype and paratype, ♂, Ross and Schlinger, CAS. Paratypes: Panama Canal Zone: Summit, September 1946, ♂, N. H. L. Krauss, USNM. Costa Rica: San Mateo, Higuito, ♂ macerated, Pablo Schild, USNM. Mexico: Vera Cruz, Cordoba, Apr. 13, 1908, ♂, Dr. A. Feynes, USNM.

One of the Los Rios specimens is in my collection.

***Sphaerocera (Parasphaerocera) chimborazo*, new species**

Males and females. Generally like *S. ecuadoria*, new species, but differs as follows: Legs slightly darker though still yellow brown. Size slightly larger, length at least 3.0 mm. Facial plate raised into a convex rounded boss, quite conspicuous in profile. Prosternum consisting of a small posterior triangle, of which the tip is rounded in the female, linear projection scarcely sclerotized. Legs somewhat longer and less thickened, even in the ♂, hindtibial spur scarcely detectable; ♂ forefemur with a row of short outstanding ventral bristles on proximal half. Abdominal spots somewhat larger. Male genitalia rather large, with tergite in profile somewhat angularly produced, evidently somewhat angularly emarginate, but most of the structures hidden; sternites 1+2 (fig. 13) represented by a single pear-shaped central spot; sternite 3 narrowly rectangular, very slightly widened at each end; sternite 4 generally rectangular, slightly widened posteriorly, about twice as long as broad, produced spoutlike beneath the genitalia; sternite 5 hidden. Female with anterior abdominal spot more produced at sides posteriorly than in male; sternite 1+2 (fig. 14) as in ♂, sternite 3 not sclerotized, sternite 4 more than twice as long as broad, somewhat narrowed at each end, sternite 5 trapeziform, anterior and posterior margins straight, sides somewhat concave; cerci oval, yellowish, with a moderate dorsal and apical bristle.

Ecuador: Chimborazo, Bugna, holotype ♂, allotype ♀, R. Levi-Castillo, USNM type no. 66592.

The sexes easily can be associated in this species by the structure of the face and prosternum.

Sphaerocera (Parasphaerocera) bimaculata Williston

Sphaerocera bimaculata Williston, 1896, Trans. Ent. Soc. London, p. 435.

This species was described from St. Vincent; two females, both marked as co-types, are in the British Museum collection (BM), together with another female from Grenada. I have no reliable evidence at present that the species occurs elsewhere; all older records from Florida and Central America require confirmation.

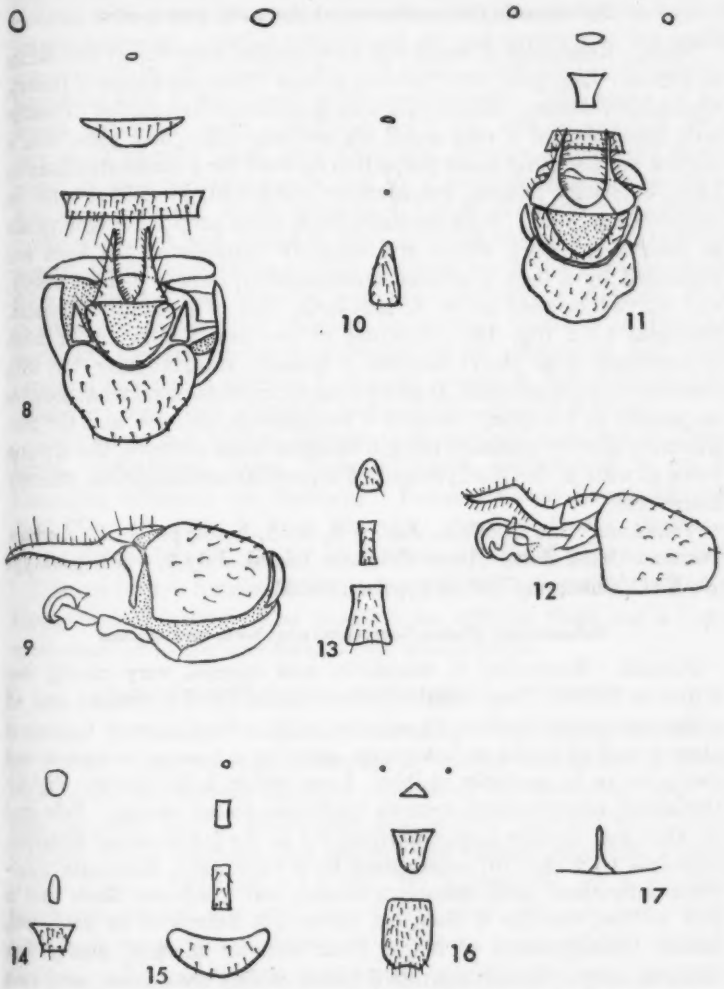
Female. Close to *S. ecuadoria*, new species, but differing as follows: Legs uniformly bright yellow brown. Size slightly smaller. Abdominal pale spots larger, both wider and longer. Prosternum with a narrow very transverse posterior piece, almost fused with the mesosternum, and a short almost linear anterior process, which in one ♀ is hardly sclerotized. Hindtibial spur very small indeed. Hindbasitarsus a fraction larger. Sternites 1+2 (fig. 15) represented by a minute sclerotized point; sternite 3 small, subrectangular, three times as long as broad; sternite 5 subcrescentic; cerci yellow, each with about 6 rather long hairs.

Windward Islands: St. Vincent, 2 ♀ co-types, H. H. Smith; Grenada, Balthazar, ♀, H. H. Smith, BM.

Among the *S. bimaculata* are 1♂ and 1♀ (latter headless) also from Balthazar but apparently belonging to *Sphaerocera* (s.s.) species. The abdomen has no pale spots; the face is partly orange, the antennal foveae rather deep, with a distinct prominence below, on which stands a short but rather stout bristle; ventral hindtibial spur long but weak and rather hairlike. A female close to *S. bimaculata* but apparently different comes from Panama Canal Zone (Barro Colorado Island, July 16, 1923, R. C. Shannon). In it the sides of sternites 3 and 4 are straight, not sinuous, and sternite 4 is considerably longer.

Sphaerocera (Parasphaerocera) levicastilli, new species

Male. Resembles *S. ecuadoria*, new species, very closely but differs as follows: Coxae and femora whitish, apical third of femora, tibiae, and tarsi light brown. Prosternum (fig. 17) consisting of a small equitriangular plate attached to the mesosternum with a narrow projection forward nearly twice as long as plate. Legs not thickened, hindtibiae with no anteroventral spur. Male genitalia large, with tergite rather distinctly emarginate to receive the cerci, which are separated by a deep V-shaped emargination; details of genitalia concealed. Sternites 1+2 (fig. 16) consisting of two round sclerotized dots and a small triangular plate; sternite 3 subtriangular, narrowing posteriorly but posterior end rounded, length less than twice the proximal width; sternite 4 subtriangular, quite wide, less than twice as long as wide, posterior end slightly narrowed before apex and weakly emarginate; sternite 5 almost completely hidden, transverse.



FIGURES 8–17.—*Sphaerocera trapezina*, new species: 8, Abdominal sternites and genitalia, ♂. 9, Genitalia, ♂, from the right. 10, Abdominal sternites 1–4, ♀. *Sphaerocera tertia*, new species: 11, Abdominal sternites and genitalia, ♂. 12, Genitalia, ♂, from the right. *Sphaerocera chimborazo*, new species: 13, Abdominal sternites 1–4, ♂. 14, Abdominal sternites 1–4, ♀. *Sphaerocera bimaculata* Williston: 15, Abdominal sternites 1–5, ♀. *Sphaerocera levicastilli*, new species: 16, Abdominal sternites 1–4, ♂. 17, Prosternum, ♂.

Ecuador: Chimborazo, Naranjapata, Chilicay, June 16, 1955, ♂ holotype and paratype, R. Levi-Castillo, USNM type no. 66593.

***Sphaerocera (Parasphaerocera) shannoni*, new species**

Male. Resembles *S. ecuadoria*, new species, very closely but differs as follows: Legs pale yellow brown, neither tibiae nor apices of femora, appreciably darker. Abdominal pale spots somewhat smaller. Prosternum consisting of a very small transversely triangular plate with a narrow but not quite linear projection forward for a moderate distance. Legs, especially femora, considerably thickened, hindtibiae with no anteroventral spur. Male genitalia large, ninth tergite not emarginate to receive the cerci, which are obliquely truncate at the apex and separated by a deep U-shaped emargination; forceps yellow, bristly, and curved upward as in *S. ecuadoria*, rest of genitalia concealed. Sternites 1+2 (fig. 18) consisting of two small dots and a small transversely oval plate; sternite 3 broadly subtriangular but with posterior margin rounded, anterior margin and sides somewhat concave (especially in the type); sternite 4 trapeziform, anterior and the considerably shorter posterior margin straight, sides concave, the sternite twice as wide as the third; sternite 5 somewhat asymmetrical, strongly transverse.

Venezuela: San Esteban, Jan. 1–6, 1940, holotype ♂, P. Anduze. Panama Canal Zone: Barro Colorado Island, July 9, 1923, paratype ♂, R. C. Shannon, USNM type no. 66594.

***Sphaerocera (Parasphaerocera) amphora*, new species**

Female. Resembles *S. ecuadoria*, new species, very closely but differs as follows: Legs whitish yellow, apical third of femora and all tibiae somewhat darker. Prosternum with a very narrow transverse plate attached to the mesosternum, anterior extension so narrow and feeble as to be scarcely visible. Legs rather long, femora slightly thickened, anteroventral spur on hindtibiae rather strong. Pale spot on abdomen slightly larger, particularly in the longitudinal direction. Sternites 1+2 (fig. 19) represented by a very small, distinctly transverse sclerotized spot; sternite 3 absent, but a minute black spot is just visible; sternite 4 elongate, somewhat narrowed at each end, widest three-quarters of length from anterior margin, nearly four times as long as broad; sternite 5 rather widely crescentic; cerci each with two long, almost straight bristles; 4 spiracles visible in the very wide, white abdominal membrane.

Ecuador: Chimborazo, Linje, July 1955, ♀ holotype; Bugna, ♀ paratype, R. Levi-Castillo, USNM type no. 66596.

***Sphaerocera (Parasphaerocera) xiphosternum*, new species**

Female. Resembles *S. ecuadoria*, new species, very closely but differs as follows: On the average, slightly smaller. Legs whitish yellow, apical third of femora and all tibiae somewhat darker. Pro-

sternum with a very transverse obtusely triangular plate attached to the mesosternum, anterior extension short and narrow but not really linear except in one specimen from Higuito. Legs slightly thickened, hindtibiae with a very small anteroventral spur. Pale spots on abdomen about the same. Sternites 1+2 (fig. 20) represented by a very small circular black sclerotized dot; sternite 3 normally represented by pale membrane only, but by a small elongate dot in specimen from Albrook Field; sternite 4 rather elongate, considerably narrowed at each end, widest at three-quarters of length from anterior margin, about three times as long as broad or, in the Panama specimens, somewhat less; shape of posterior end varying in Costa Rica specimens from rounded truncate to rounded pointed; in Panama specimens the sternite is considerably wider posteriorly and more narrowed anteriorly; sternite 5 rounded crescentic, not very strongly transverse; cerci each with two rather short, straight bristles.

Costa Rica: San Mateo, Higuito, holotype and paratype ♀, Pablo Schild. Paratypes: Costa Rica, ♀, Schild (determined to be *S. bimaculata* Williston by Malloch). Panama Canal Zone: Albrook Field, June 19, 1952, ♀, F. S. Blanton. Panama: Darien Province, Patino Point, July 12, 1952, ♀, F. S. Blanton, USNM type no. 66595.

This set of five females is somewhat variable but perhaps all may belong to one species. The female from Albrook Field has a large mite attached to the underside of the mouth parts.

***Sphaerocera (Parasphaerocera) musiphila*, new species**

Male. Resembles *S. ecuadoria*, new species, very closely but differs as follows: Legs yellowish white, apical third of femora and all tibiae slightly darker, femora strongly thickened, anteroventral spur of hindtibia very small. Prosternum with a transverse triangular plate attached to the mesosternum, anterior extension of moderate length, almost linear. Sternites 1+2 (fig. 21) represented by a strongly transverse central dot and lateral dots that also are transverse; sternite 3 trapeziform, almost as broad as long, anterior margin straight, sides converging posteriorly, slightly concave, posterior margin also slightly concave; sternite 4 transverse, more than twice as wide as long, trapeziform with posterior margin shallowly emarginate, sides straight, diverging posteriorly; sternite 5 almost rectangular, much larger than 4, about four times as wide as long; genitalia with ninth tergite somewhat hollowed out on each side, emarginate to receive the cerci, which are separated by a wide V-shaped emargination.

Panama: bananas, Sept. 8, 1932, holotype ♂, CAS.

***Sphaerocera (Parasphaerocera) transversalis*, new species**

Male. Resembles *S. ecuadoria*, new species, very closely but differs as follows: Size slightly smaller. Facial plate (fig. 23) considerably shorter in longitudinal direction, more transverse. Legs yellowish white, apical third of femora and all tibiae slightly darker, femora scarcely thickened, anteroventral spur of hindtibia hardly developed. Prosternum at surface entirely membranous. Abdominal pale spots distinctly larger, tergite 5 with a narrow white membranous area both anteriorly and posteriorly. Sternites 1+2 (fig. 22) represented by a rounded rectangular plate that is just transverse, no lateral dots; sternite 3 rectangular with posterior corners slightly rounded, about one and one-half times as long as broad; sternite 4 rather small, rectangular, not quite twice as wide as long; sternite 5 partly concealed beneath 4, not much wider; genitalia with ninth tergite bearing a small central knob, somewhat emarginate to receive the cerci, which are separated by a U-shaped emargination.

Ecuador: Guayas, Cuatro Hermanitos Experimental Farm, Feb. 28, 1955, holotype ♂, R. Levi-Castillo, USNM type no. 66598.

***Sphaerocera (Parasphaerocera) lepida*, new species**

Female. Resembles *S. ecuadoria*, new species, but differs as follows: Facial plate more transverse. Legs yellowish white, apical third of femora and four hindtibiae somewhat darker, foretibiae blackish, anteroventral spur of hindtibia very small. Prosternum (fig. 25) shaped somewhat like a spearhead, sides angularly widened anteriorly where there is a narrow forward projection. Abdominal pale spots very large, tergite 5 divided centrally by a pale line. Sternites 1+2 (fig. 24) represented by an almost square central plate, not very small; sternite 3 considerably smaller, longer than broad; sternite 4 narrowed anteriorly, straight posteriorly, about twice as long as wide; sternite 5 almost rectangular, sides hardly rounded, cerci concealed.

Panama Canal Zone: Fort Kobb, Camaron, July 17, 1952, holotype ♀, F. S. Blanton, USNM type no. 66597.

***Sphaerocera (Parasphaerocera) transversa*, new species**

Female. Close to *S. lepida*, new species, but evidently distinct. Legs whitish yellow, apices of femora slightly darker; hindtibia with no anteroventral spur. Abdominal pale spots relatively small, anterior one with sides straight, posterior margin slightly convex, posterior one oval with lateral ends pointed. Sternites 1+2 represented by a rectangular transverse plate nearly twice as wide as hindfemur; sternite 4 somewhat more than twice as long as wide, posterior margin straight, sides slightly convergent anteriorly, anterior margin rounded;

sternite 5 trapeziform, sides straight, as long as anterior width. Panama: bananas, Sept. 11, 1932, holotype ♀, CAS.

***Sphaerocera (Parasphaerocera) dissecta*, new species**

Female. Allied to *S. bimaculata* Williston but evidently distinct. Legs whitish yellow; hindtibia with no anteroventral spur. Facial plate almost an equilateral triangle. Abdominal pale spots very large, square; tergite 5 consisting of two small oval plates separated by white membrane. Sternites 1+2 represented by a diamond-shaped spot not quite as wide as hindfemur, angles directed anteroposteriorly, other two laterally; sternite 3 small, width slightly greater than that of hindtibia, anterior margin rounded, posterior margin straight; sternite 4 more than twice as long as wide posteriorly, anterior margin rounded, posterior margin straight, sides somewhat convergent forward; sternite 5 rounded, crescentic, transverse.

Panama: bananas, Sept. 22, 1932, holotype ♀, CAS.

Other Species of Subgenus *Parasphaerocera*

I have placed near *S. bimaculata* Williston those species of the subgenus that have both pale abdominal spots and entirely pale legs. There are a number of other species that have either the femora more or less blackened or the abdominal spots very reduced or absent.

***Sphaerocera (Parasphaerocera) varipes* Malloch**

Sphaerocera varipes Malloch, 1925, Proc. Ent. Soc. Washington, vol. 27, p. 121.

Malloch described this species from 5 females from Costa Rica, San Mateo, Higuito, and I have examined the holotype. As far as I can make out, there is only one species in which the femora are half black. This is redescribed below:

Males and females. Black; antennae and legs yellow brown, coxae and proximal half of femora black, trochanters pale. Abdominal pale spots somewhat larger than in *S. ecuadoria*, new species, their margins rather rounded. Length 2.5–3.0 mm.

Facial plate flattened, transversely trapeziform. Prosternum consisting of a small transverse triangular plate attached to the mesosternum, anterior extension of moderate length, not quite linear. Femora distinctly thickened in the male, hindtibia with no anteroventral spur. Three anterior abdominal spiracles forming distinct black spots in the white sternal membrane. Male with sternites 1+2 (fig. 26) represented by a small oval central dot; sternite 3 rather small, about twice as broad, somewhat rounded at each end and slightly narrowed posteriorly; sternite 4 slightly broader than long, subrectangular, posterior margin straight, sides and anterior margin slightly

rounded; sternite 5 short, very transverse; genitalia rather small, ninth tergite emarginate to receive the cerci, which apparently are separated by a rather narrow V-shaped membranous area. Female with sternites 1+2 (fig. 27) represented by a small oval central plate; sternite 3 not sclerotized; sternite 4 almost parallel sided, slightly narrowed posteriorly, where it is somewhat rounded, about three times as long as broad; sternite 5 somewhat widely crescentic, cerci hidden.

Specimens examined: Costa Rica: San Mateo, Higuito, ♀ type, P. Schild; San José, July, ♀, H. Schmidt, USNM. Panama: bananas, Aug. 25 and Sept. 22, 1932, 2 ♂, CAS.

In the collection of the USNM are eight more females that seem to belong to the same species; they come from Costa Rica, Honduras, San Francisco ex Guatemala, and one definitely from the United States—Georgia: Savannah, Oct. 12, 1953, privy trap, J. W. Kilpatrick.

Sphaerocera (Parasphaerocera) pallipes Malloch

Sphaerocera pallipes Malloch, 1914, Ent. News, vol. 25, p. 31.

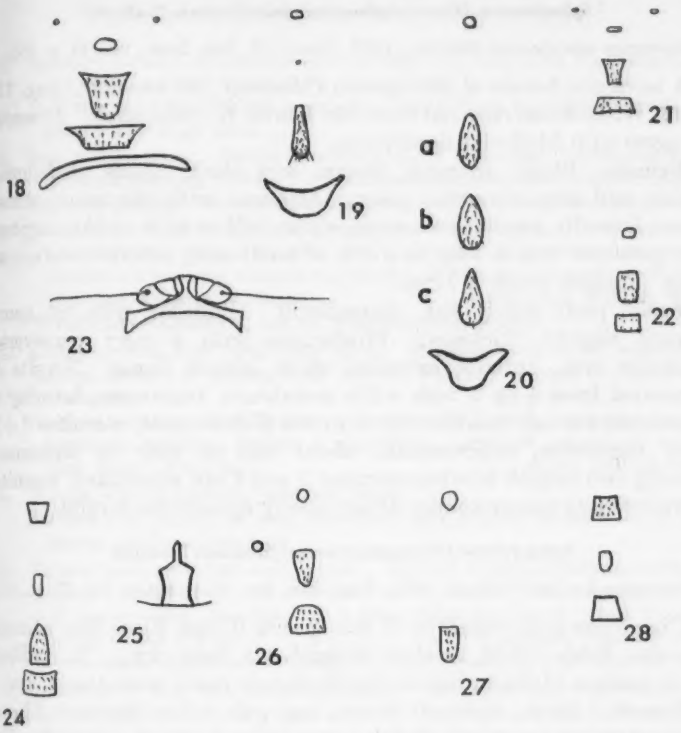
This species was described originally from Panama: Buena Ventura, May 19, 1911, ♀, USNM. I have examined the type. The species and its allies resemble those of the subgenus *Parasphaerocera* but lack or, in one form described below, almost lack the pale abdominal spots, the tergites being uniformly dark and sclerotized. Malloch (1925, p. 121) states he has seen many additional specimens from Panama, but, as I have now seen three forms (at least two species) of this group, I feel that the material should be re-examined. I did not find a long series in the USNM.

Redescription of type: Female. Legs yellow brown, hindtibia without anteroventral spur. Size somewhat smaller than *S. ecuadoria*, new species. Sternites 1+2 represented by a plate that is rather narrowly pear shaped; sternite 3 narrow, almost linear; sternite 4 long trapeziform, narrowing posteriorly, about twice as long as anteriorly broad; corners not rounded. Abdomen entirely black dorsally.

Sphaerocera (Parasphaerocera) guttula, new species

Female. Black; antennae pale brown; legs pale yellow brown. Abdomen with very small transverse pale spots; one-fifth as wide as tergites, length about equal to width of hindtibia. Length about 2.5 mm.

Facial plate almost flat, trapeziform. Prosternum with a small transverse triangular posterior area that is produced anteriorly into a short gradually narrowing extension. Hindtibia with no anteroventral spur, femora slightly thickened. Tergite 5 very transverse posteriorly rounded. Sternites 1+2 (fig. 28) represented by a nearly square plate, width not quite twice that of hindfemur; sternite 3



FIGURES 18–28.—*Sphaerocera shannoni*, new species: 18, Abdominal sternites 1–5, ♂. *Sphaerocera amphora*, new species: 19, Abdominal sternites 1–5, ♀. *Sphaerocera xiphosternum*, new species: 20, Abdominal sternites 1–5, ♀, sternite 4 shown for each of three specimens: *a*, Higuito; *b*, Albrook Field; *c*, Patino Point. *Sphaerocera musiphila*, new species: 21, Abdominal sternites 1–4, ♂. *Sphaerocera transversalis*, new species: 22, Abdominal sternites 1–4, ♂. 23, Facial plate, ♂. *Sphaerocera lepida*, new species: 24, Abdominal sternites 1–5, ♀. 25, Prosternum, ♀. *Sphaerocera varipes* Malloch: 26, Abdominal sternites 1–4, ♂. 27, Abdominal sternites 1–4, ♀, sternite 3 completely desclerotized. *Sphaerocera guttula*, new species: 28, Abdominal sternites 1–4, ♀.

almost oval but posterior margin somewhat truncate, length two-thirds, width one-half that of sternites 1+2; sternite 4 nearly square, much like sternites 1+2; sternite 5 trapeziform, sides straight, converging posteriorly, anterior and posterior margins nearly straight; cerci each with about three straight moderately long hairs.

Panama Canal Zone: Erwin Island, July 18, 1923, holotype ♀, R. C. Shannon (received in exchange from Mr. Curtis Sabrosky as *S. pallipes* Malloch, now in the British Museum).

Sphaerocera (Parasphaerocera) annulicornis Malloch

Sphaerocera annulicornis Malloch, 1913, Proc. U.S. Nat. Mus., vol. 44, p. 363.

I have one female of this species (Missouri: Shrewsbury, Aug. 17, 1949, W. Downes, received from Mr. Curtis W. Sabrosky). It seems to agree with Malloch's description.

Female. Black; antennae brown; legs black, apices of femora, tibiae, and tarsi somewhat paler. Abdomen with two small transverse, laterally pointed pale spots, about half as wide as the tergites, and posterior one as long as width of hindfemur, anterior one not so long. Length nearly 3.0 mm.

Facial plate nearly flat, trapeziform. Hindtibia with no spur, femora slightly thickened. Prosternum with a very transverse posterior area, anterior extension short, almost linear. Tergite 5 separated from 4 by a wide white membrane, transverse, forming a somewhat curved, hoodlike cover to the fifth sternite; sternites 1+2 very transverse, subcrescentic, about half as wide as abdomen, bearing two longish bristles; sternites 3 and 4 not sclerotized; sternite 5 transversely subcrescentic, fitting closely against the tergite.

Sphaerocera (Parasphaerocera) flavicoxa Malloch

Sphaerocera flavicoxa Malloch, 1925, Proc. Ent. Soc. Washington, vol. 27, p. 121.

I have one male paratype of this species (Costa Rica: San Mateo, Higuito, Pablo Schild, received through Mr. Sabrosky). It is allied to *S. pallipes* Malloch, but the facial plate is much more transverse.

Female. Black; antennae brown, legs pale yellow brown. Abdomen with two very small transverse pale spots, the first hardly traceable, the second one-fifth the width of the abdomen and hardly as long as basal width of hindtibia. Length somewhat more than 2.0 mm.

Facial plate flat, forming a very transverse small triangle with its sides somewhat concave. Hindtibia with a very small black anteroventral spur, femora slightly thickened. Prosternum with a transverse posterior area and a short linear anterior extension. Fifth tergite transverse, posterior margin nearly straight. Sternites 1+2 represented by dots at extreme sides and a transversely oval central plate about as wide as hindfemur; sternite 3 subtrapeziform with anterior margin straight, sides slightly concave, posterior margin somewhat rounded, half as wide again as 1+2, transverse, about one and one-half times as broad in the middle as long; sternite 4 subrectangular, nearly twice as broad as long; sternite 5 slightly visible, very transverse; genitalia rather large, tergite 9 not emarginate to receive the cerci, which are separated by a narrow U-shaped emargination.

Key to Species of Subgenus *Parasphaerocera* Spuler [3]

1. Abdomen dorsally with no pale spots or with very small ones, much less than half as long or half as wide as a tergal plate 2
   Abdomen dorsally with two large pale spots, at least two-thirds as wide or as long as a tergal plate 5
2. Legs mainly black. Neither sternite 3 nor 4 sclerotized. Abdomen with two small pale spots (U.S.A.) . . **Sphaeracera annulicornis** Malloch, 1913, ♀
   Legs entirely pale. Sternites 3 and 4 represented by at least small plates . 3
3. Facial plate in form of a small, very transverse triangle. Abdomen with two small pale spots. Sternites (♂) 1+2 with a small oval central plate, sternite 3 transverse, rounded posteriorly, sternite 4 subrectangular (Costa Rica and, apparently, Brazil) . . . . . **S. flavicoxa** Malloch, 1925
   Facial plate trapeziform, not so transverse (only ♀ seen) 4
4. Abdomen with two small pale spots. Sternites 1+2 large, subrectangular, sternite 3 smaller, oval, sternite 4 square, sternite 5 trapeziform (Panama) . . . . . **S. guttula,** new species
   Abdomen entirely black dorsally. Sternites 1+2 small, pyriform, sternite 3 narrow, sublinear, sternite 4 trapeziform, narrowed posteriorly, longer than broad (Panama) . . . . . **S. pallipes** Malloch, 1913
5. Femora with at least the basal half black 6
   Femora pale yellow, at most the distal part slightly browner or, in one species, the foretibiae dark 8
6. Femora with distal half sharply pale. Sternite 3 small, pyriform, twice as long as broad in ♂, not sclerotized in ♀; sternite 4 subrectangular, in ♂ rather wider than long, in ♀ three times as long as broad (Central America and U.S.A.) . . . . . **S. varipes** Malloch, 1913
   Femora black, apices narrowly pale (not seen, separation after Malloch) . 7
7. Venter of ♀ with two sclerotized plates. Cheeks closely striate in middle (Florida) . . . . . **S. striata** Malloch, 1925
   Venter of ♀ with three sclerotized plates. Cheeks not striate in middle (Maryland) . . . . . **S. nigrifemur** Malloch, 1925
8. Males 9
   Females 15
9. Sternite 4 not transverse, sternite 5 concealed. Ninth tergite emarginate, cerci separated by deep V-shaped emargination. Prosternum with small triangular plate with a narrow anterior projection (Ecuador) . . 10
   Sternite 4 distinctly transverse 11
10. Facial plate raised into a rounded convex boss. Sternite 3 parallel sided. **S. chimborazo,** new species
    Facial plate flat. Sternite 3 clearly narrowed posteriorly. **S. levicastilli,** new species
11. Sternite 3 transverse, widely trapeziform with posterior margin slightly concave; sternite 4 about six times as wide as long (Ecuador). **S. trapezina,** new species
    Sternite 3 not transverse 12
12. Sternites 3 and 4 rectangular (Ecuador) . . . **S. transversalis,** new species
    Sternite 3 clearly not rectangular 13

[3] *S. galapagensis* Curran, 1934, runs down in this key to *S. varipes* Malloch and cannot be distinguished from it by any character mentioned in the description.

13. Sternite 3 trapeziform, about as long as posteriorly broad, sides and posterior margin slightly concave (Panama) . . . **S. musiphila,** new species
Sternite 3 broadly subtriangular, rounded posteriorly, one-half to one-third as wide as sternite 4 14
Sternite 3 very small, not more than one-quarter as wide as sternite 4, elongate with concave sides, dumbbell shaped; sternite 4 five or six times as wide as long (Panama, Ecuador) . . . . **S. tertia,** new species
14. Sternite 4 about four times as wide as long; sides of sternite 3 strongly concave, sternite 2 small (Ecuador) . . . . . **S. ecuadoria,** new species
Sternite 4 about two and one-half to three times as wide as long. Sides of sternite 3 weakly concave, sternite 2 much narrower (Panama and Venezuela) . . . . . **S. shannoni,** new species
15. Facial plate with a rounded convex boss. Prosternum with a posterior triangular plate and a disconnected linear piece. Posterior pale abdominal spot with a linear extension to the margin. Sternites 1+2 relatively large, sternite 3 not sclerotized, sternite 4 small and elongate, sternite 5 angular, trapeziform (Ecuador) . . . . . **S. chimborazo,** new species
Facial plate flat 16
16. Sternite 3 completely unsclerotized. Sternite 5 more or less rounded crescentic 17
Sternite 3 with a distinct, even if small, plate 18
17. Prosternum anteriorly narrow but not strictly linear. Sternite 4 smaller, clearly narrowed posteriorly; sternites 1+2 a circular dot; sternite 3 absent, or, rarely, represented by a minute sclerotized dot (Panama, Costa Rica, Mexico) . . . . . **S. xiphosternum,** new species
Prosternum with a very transverse posterior sclerotization, anteriorly not visible above surface. Sternite 4 longer and less distinctly narrowed posteriorly; sternites 1+2 transverse (Ecuador). **S. amphora,** new species
18. Sternite 4 long, fully four times as long as broad; sternite 5 rounded crescentic (Ecuador) . . . . . **S. ecuadoria,** new species
Sternite 4 not very long, at most three times as long as broad 19
19. Sternite 2 large, rectangular; sternite 5 angular, sides straight 20
Sternite 2 dotlike or, if slightly larger, diamond shaped; sternite 5 rounded crescentic 21
20. Facial plate unusually transverse. Prosternum large subtriangular. Foretibia black. Abdominal pale spots very large. Sternite 4 rectangular with anterior end almost pointed (Panama) . . . **S. lepida,** new species
Facial plate normal as in figure 7. Foretibia pale. Abdominal pale spots smaller than usual. Sternite 4 subrectangular, rounded and somewhat narrowed anteriorly (Panama) . . . . . **S. transversa,** new species
21. Abdominal pale spots square, very large; tergite 5 divided centrally by a pale line. Sternite 2 diamond shaped, angles pointing anteriorly and posteriorly, nearly as wide as hindfemur; sternite 3 with posterior margin straight, anterior end rounded, not quite as wide as hindtibia; sternite 4 with posterior margin straight, sides considerably convergent anteriorly where it is rounded (Panama) . . . . . **S. dissecta,** new species
Abdominal pale spots rounded; tergite 5 not divided by a pale line. Stergite 2 dotlike or rectangular. Prosternum with a short very transverse piece posteriorly and a narrow anterior extension 22

22. Sternite 3 dotlike, sternite 4 pyriform. Anterior part of prosternum wider. Abdominal pale spot as *S. ecuadoria*, new species (Ecuador).
S. trapezina, new species

Sternite 3 small but rectangular, sternite 4 rectangular, nearly three times as long as broad. Abdominal pale spots larger (St. Vincent and Grenada B.W.I.) . . . . . **S. bimaculata**, Williston

The Association of Acarina with Subgenus *Parasphaerocera*

Four of the males and six of the females of *S.* (*P.*) *ecuadoria* had a large mite hanging beneath the mentum. All the mites were attached with their heads by the foramen of the fly and with their dorsum directed downward. One of the mites was determined by Mr. E. Lindgren as *Macrocheles* sp. aff. *insignitus* Berlese. A specimen of *S.* (*P.*) *xiphosternum* from Panama, Albrook Field, had a similar mite on its mentum.

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HERPETOLOGY
OF THE ZUNI MOUNTAINS REGION, NORTHWESTERN NEW MEXICO

By FREDERICK R. GEHLBACH

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HERPETOLOGY OF THE ZUNI MOUNTAINS REGION, NORTHWESTERN NEW MEXICO[1]

By Frederick R. Gehlbach[2]

Introduction

In decided contrast to the amount of herpetological information available for other southwestern states, relatively little is known about amphibians and reptiles in New Mexico. Several taxonomic papers have dealt with members of the state herpetofauna, but none have treated local distribution and differentiation in detail. It is the intent of this study, and of others in progress, to describe the amphibians and reptiles of New Mexico by natural regions, with the aim of understanding local variation in morphology, distribution, and life history.

Field observations and specimens obtained during portions of the summers of 1951, 1954, and 1955 constituted a preliminary survey of amphibian and reptilian species in northwestern New Mexico. Thereafter, emphasis was placed on the Zuni region as a biogeographic unit. Local studies of ecology and assumed gene flow were made

[1] Modified from a master's thesis submitted to Cornell University, 1959.

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intermittently during June–September in 1956 and 1957, and during June–August in 1958 and 1959. Additional data on vegetation were recorded in August 1960; a few herpetological specimens were added at this time and in July–August 1961. Altogether, 132 days and nights were spent in the field in the area covered by figure 1.

A long history of random herpetological collecting in the Zuni region has preceded these investigations. S. W. Woodhouse, a member of the 1851 Sitgreaves Expedition, first obtained representatives of the local herpetofauna. Two new species, *Tapaya ornatissima* (=*Phrynosoma douglassi hernandesi*) and *Pityophis affinis* (=*Pituophis melanoleucus affinis*) were described from among his specimens. Personnel associated with the United States Army at Fort Wingate, the U.S. Biological Survey, and various U.S. railway and army explorations west of the one-hundredth meridian, especially V. Bailey, E. A. Goldman, H. W. Henshaw, C. G. Newberry, and R. W. Shufeldt, contributed specimens prior to 1910. This historically important material is housed in the U.S. National Museum. E. T. Hooper and W. L. Chenoweth collected amphibians and reptiles in 1939 and 1949–1951 respectively; their specimens and my own have been deposited in the Museum of Zoology, University of Michigan, and the Cornell University herpetological collection.

Aspects of this study were discussed with several persons, especially Bruce B. Collette, Norman Hartweg, Charles F. Walker, and Thomas M. Uzzell, Jr. William J. Hamilton, Jr., at Cornell University and Norman Hartweg and Charles F. Walker at the University of Michigan greatly facilitated my research. William L. Chenoweth, Hillis L. Howie, and Rossiter D. Olmstead were contributors to success in the field. Edward C. Raney provided the opportunity for a trip to the U.S. National Museum, where Doris M. Cochran aided my quest for specimens and historical data. Stanwyn G. Shetler identified certain plants. My wife, Nancy Y. Gehlbach, helped with vegetational analyses and typed the manuscript. A Sigma Xi grant-in-aid for research made part of the 1958 field work possible.

The following loaned specimens or provided specific information about them: Curtis Allen, James D. Anderson, Ralph W. Axtell, W. Frank Blair, J. Roger Bider, Charles M. Bogert, James E. Böhlke, Bryce C. Brown, William G. Degenhardt, Floyd L. Downs, William E. Duellman, James S. Findley, Joe Gorman, Michael Hays, Arthur H. Harris, Norman Hartweg, Robert F. Inger, Clyde J. Jones, Laurence M. Klauber, John M. Legler, Paul Licht, Edmond V. Malnate, T. Paul Maslin, Samuel B. McDowell, Robert R. Miller, Jon A. Peterson, Paul W. Parmalee, Jay M. Sheppard, Hobart M. Smith, Wilmer W. Tanner, Robert W. Risebrough, Robert C. Stebbins, David A. West, Ernest E. Williams, Kenneth L. Williams, and Richard G. Zweifel.

I am very grateful to each of the above persons and institutions. I am equally indebted to the Prairie Trekers, whose efforts in my behalf produced many specimens and much inspiration; I dedicate this paper to them.

Physical and Climatic Environments

The study area, referred to as the Zuni region or Zunis, includes most of McKinley and Valencia Counties, New Mexico (fig. 1). It is situated in portions of both Datil and Navajo Sections of the Colorado Plateau at the southeastern extremity of this physiographic province (Hunt, 1956, fig. 1). Elevations range from 5794 to 11,389 feet. The diverse topography and semiarid climate, with their attendant effects on vegetation, greatly influence herpetofaunal distribution.

Topography

Most spacious of the various topographical features are the Zuni Mountains, a domal uplift approximately 25 miles wide and 70 miles long, lying northwest by southeast near the southeastern edge of the Colorado Plateau. Strata surrounding the dome are gently sloping Pennsylvanian through Cretaceous formations, mostly sandstones (Fenneman, 1931, pp. 217–319). Rock outcrops are exposed in canyons, mesas, and the great retreating cliffs characteristic of Colorado Plateau topography. These major erosional features probably were formed no earlier than the Miocene and, along with the entire Plateau, have been uplifted in Pliocene and Pleistocene times (Hunt, 1956). The summit of Mount Sedgwick at 9156 feet is the highest point above the basal plain, which averages 7000 feet.

Running along Oso Ridge, the Continental Divide separates the Zuni Mountains almost equally into eastern and western watersheds. The former is partly drained by Azul and Bluewater Creeks, which flow into the Rio San Jose and ultimately into the Rio Grande. The latter is drained by the Rio Puerco (this name is also given to a stream of the Rio Grande basin), Rio Nutria, and Zuni River, which empty into the Little Colorado River. All streams, except the headwaters of the Zuni, are intermittent, and steady flow occurs only during the summer period of heaviest precipitation. Bluewater Lake and Ramah Reservoir are relatively permanent man-made features.

Between the Zuni Mountains and other structural upwarps are broad, open valleys such as the Gallup-Zuni Basin. The strata of this basin slope gently westward from the Zuni Mountains, decreasing from 8000 feet to 6500 feet toward the mouth of the Zuni River. Such features give the region its continuous yet vertically diverse aspect. To the north, gently undulating topography of the Navajo

FIGURE 1.—Zuni Mountains region, adapted from the U.S. Coast and Geodetic Survey, Albuquerque and Douglas Aeronautical Charts, 1957. (Major lava beds are indicated by diagonal lines; other topographic features are stippled. Position of the region within New Mexico is shown by the inset map.)

Section continues into the San Juan Basin. On the south the Zunis and North Plains of the Datil Section are replaced by the San Augustine Plains and rugged montane highlands associated with the Basin and Range physiographic province.

East of the Zuni Mountains, Mount Taylor, an 11,389 foot Miocene volcano, dominates the area of eroded, basalt-capped mesas known collectively as the San Mateo Mountains (not to be confused with an uplift of the same name in Socorro County). Mesa Chivato is the northeastern extension of this highland mass, which is approximately 15 by 35 miles in extent. Its slopes are drained by the Rio San Jose and Chico Arroyo and drop to 5794 feet at Laguna on the eastern end of the study area. This is about the southeastern boundary of the Colorado Plateau as marked by the westernmost faults of the Rio Grande (Hunt, 1956, p. 6).

Extensive lava beds or malpais, derived in part from Mount Taylor, are most conspicuous south of Grants. They stretch 30 miles on a southwesterly-northeasterly axis and are surrounded by a relatively flat plain several feet lower than the overrun lava. Cinder cones border the main malpais, which ranges from 8308 feet at the top of Flagpole Crater to 6200 feet near McCarteys. Much soil has accumulated where the lava is relatively smooth, as in the vicinity of El Morro National Monument and Cebolleta Mesa. This basalt is probably of late Miocene origin, whereas rough, broken malpais along the Rio San Jose near Grants is of Pleistocene derivation (Hunt, 1956, pp. 46, 53). The McCarteys lava may be less than 1200 years old (Nichols, 1946, p. 1049). North of Bluewater another small malpais lies isolated on the Cretaceous plain and, near it, numerous volcanic necks stud the landscape.

Climate

The Zunis are characterized by a semiarid-mesothermal climatic regime with a P–E Index of 16–32 (Thornthwaite, 1931). It may be seen that local moisture conditions are allied closely with elevation and exposure (fig. 2). Prevailing air currents are southwesterly. Below 8000 feet average annual precipitation values are 13 inches on the southwest and 10 on the northeast; above 8000 feet, 20 inches is the average annual value (U.S. Dept. Comm., 1945–1957). The period of greatest rainfall occurs from July through September. Short, heavy thundershowers are then common and often result in flash floods. Heavy winter snows usually are limited to the elevations above 8000 feet.

Pearson (1931, table 14) has assembled annual mean precipitation data for various plant zones in Arizona and New Mexico. They range from 11 inches in the grasslands and 16 in pinyon-juniper

woodlands to 21 in ponderosa pine and 22 in Douglas fir zones. The evaporative effect of winds, however, limits mesophytic vegetation on exposed slopes so that correlations between precipitation and elevation are often spurious for indexing vegetational distribution.

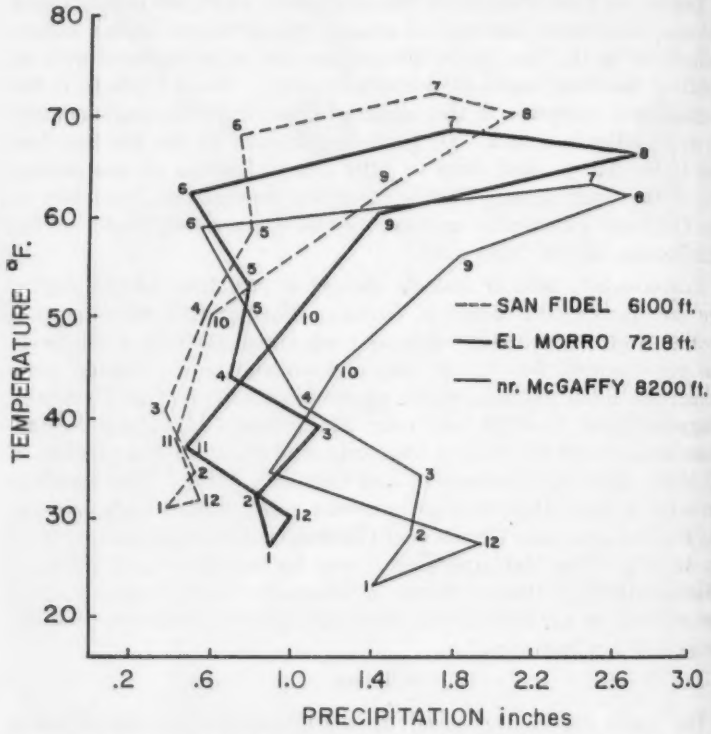


FIGURE 2.—Climatograph of three weather stations in the Zuni region. (Plotted points are mean monthly temperatures and precipitation; months are indicated by numbers. Data compiled from U.S. Department of Commerce climatological summaries for New Mexico, 1945–1957.)

Air temperatures generally fall with increasing elevation, the annual fluctuation being equally great at all stations (fig. 2). The number of days between 32° F. extremes is 123–194 ($\bar{x}$ 162) below 7000 feet, 72–148 (120) above 7000 feet (U.S. Dept. Comm., 1945–1957). Daily temperature variation is also considerable (table 1). Pearson (1931, tables 3, 4) calculated June–September maximum and minimum temperatures in New Mexico and Arizona as follows: 90, 55 (°F) in the grassland zone; 83, 52, pinyon-juniper woodland; 79, 46, ponderosa pine zone; and 74, 40, in the Douglas fir zone. Hooper

(1941, table 1) and Lindsey (1951, table 1) have presented other temperature data for the Zuni region.

TABLE 1.—*Temperature and humidity in the pinyon-juniper-ponderosa pine ecotone, 7200 feet, Cottonwood Gulch, McKinley County, New Mexico*

Measurement	1959	Value
Avg. max. temp.	July 1–31	93° F.
	August 1–20	87
Avg. min. temp.	July 1–31	51
	August 1–20	47
Max. temp.	July 3	98
Min. temp.	July 3	38
Avg. rel. humidity		
7:00 A.M.	July 1–August 10	56%
1:00 P.M.	July 1–August 10	29%

Ecological Distribution

Included in the Navahonian biotic province of Dice (1943), the Zuni region contains Plains, Roughlands, and Montane Life Belts. While these biogeographic units vary with ecologic succession and exposure, they may be employed to describe elevational distribution of amphibians and reptiles. Within each life belt, the characterization of vegetational associations and substrate conditions will further delimit herpetofaunal range. No attempt at complete vegetational analysis is made here; only the relative positions of certain aspect dominants, important in providing cover, are described. The life belts and associations are both vertically and horizontally discontinuous, becoming increasingly mesophytic with ascending elevation.

Plains Life Belt

This lowermost unit extends in patchwork fashion from 5794 feet at the eastern end of the study area to approximately 7200 feet on the lava beds near El Morro. Shrub cover is relatively sparse except in the vicinity of arroyos and around rock outcrops and mesas. The soil may consist of loose sand or clay with little rock or restricted areas of gravel and rubble. At the edges of the Zuni and San Mateo Mountains this life belt is broken by mesas included in the Roughlands Life Belt and by malpais. Part of Bailey's (1913, pp. 25–41) Upper Sonoran Zone, the mixed grasslands of Castetter (1956), the basin sagebrush and short-grass plains of Clements (1920, pp. 139–144, 156, 160); and Pearson's (1931) grassland zone are included in the Plains Life Belt.

Eight (27 percent) of the 30 species of amphibians and reptiles recorded from the Zuni region are, so far as known, restricted to this belt. They are *Scaphiopus intermontanus*, *Scaphiopus bombifrons*, *Bufo punctatus*, *Uta stansburiana*, *Holbrookia maculata*, *Thamnophis dorsalis*, *Masticophis flagellum*, and *Crotalus atrox*. Certain other species, especially *Sceloporus graciosus*, *Eumeces obsoletus*, *Pituophis melanoleucus*, and *Crotalus viridis*, appear to reach their maximum abundance here.

For the most part, the Plains Life Belt is characterized by the short-grass or mixed-grass association in which blue grama (*Boutelous gracilis*) is dominant or codominant with such other grasses as hairy grama (*B. hirsuta*) and galleta (*Hilaria jamesi*) (pl. 1A). *Holbrookia maculata* usually is found where shrub cover is sparse and composed of rabbitbush (*Chrysothamnus nauseosus*), snakeweed (*Gutierrezia sarothrae*), or narrow-leaved yucca (*Yucca glauca*). Reptile life is more varied in somewhat heavier cover, as in the saltbush-sage association dominated by shadscale saltbush (*Atriplex canescens*), spiny saltbush (*A. confertifolia*), or big sagebrush (*Artemisia tridentata*). *Sceloporus graciosus* is limited primarily to this vegetational type. *Crotalus atrox* seems similarly limited to the cholla-juniper association dominated by cholla cactus (*Opuntia imbricata*) and one-seed juniper (*Juniperus monosperma*).

Between elevations of 6500 and 7200 feet there may be an ecotone or a broad continuum between Plains and Roughlands Life Belts marked by an increased number of one-seed junipers and various taller shrubs such as mountain mahogany (*Cercocarpus montanus*). Pinyons (*Pinus edulus*) may be present. The widespread continuum could, in part, be caused by excessive grazing (Castetter, 1956, p. 272). *Eumeces obsoletus* occurs here as do most other Plains species that range into the Roughlands. Rock-strewn arroyos also permit species like *Crotaphytus collaris* and *Masticophis taeniatus* to bridge the ecological gap between the two life belts.

Roughlands Life Belt

The Roughlands Life Belt comprises rocky uplands from around 6800 feet to at least 8000 feet. Its outside elevational limits are influenced by the presence of rocky soil combined with the effects of less moisture at lower elevations and lower temperatures in Montane environments (see Castetter, 1956, p. 271). Vegetative cover is much thicker than on the plains, and outcropping sedimentary strata produce boulder piles and talus slopes, thus providing additional retreats for secretive species. This life belt includes the upper part of Bailey's (1913, pp. 25–46) Upper Sonoran Zone and lower limits of his Tran-

sition Zone in addition to the woodland biome of Castetter (1956), pinyon-cedar woodland and petran chaparral of Clements (1920, pp. 183–187, 197–199), and pinyon-juniper and lower ponderosa pine zones of Pearson (1931).

Two species, *Diadophis punctatus* and *Salvadora grahamiae*, presently are known only from this life belt but probably are more widely distributed. *Ambystoma tigrinum*, *Scaphiopus hammondi*, *Bufo woodhousei*, *Rana pipiens*, *Hyla arenicolor*, *Phrynosoma douglassi*, *Sceloporus undulatus*, *Urosaurus ornatus*, *Eumeces multivirgatus*, *Cnemidophorus velox*, and *Thamnophis elegans* reach their greatest abundance here. Other, rarer species, such as *Hypsiglena torquata* and *Crotalus molossus*, may be centered in the Roughlands Life Belt.

Dominated by pinyons, one-seed junipers, alligator junipers (*Juniperus deppeana*), and Rocky Mountains junipers (*J. scopulorum*), the pinyon-juniper association is the most widespread vegetational type (pl. 1B). Shrub cover is relatively sparse but consists of aspect dominants similar to those of the oak-mahogany association described below. Amphibians and reptiles such as *Scaphiopus hammondi*, *Phrynosoma douglassi*, and *Cnemidophorus velox* are more abundant where the pinyon-juniper resembles a rocky savanna. Openings in the savanna often are occupied by saltbush and occasionally extensive stands of big sagebrush. If large boulders are present, as on hillsides and mesa edges, *Crotaphytus collaris* and *Urosaurus ornatus* are typically present.

The oak-mahogany association is composed largely of Gambel oak (*Quercus gambeli*) and mountain mahogany. Below approximately 7000 feet, wavyleaf oak (*Q. undulata*) may replace Gambel oak. Shrubs like gooseberry (*Ribes* sp.), skunkbush (*Rhus trilobata*), and datil (*Yucca baccata*) are present in varying numbers. This association occupies canyon sides and may replace the pinyon-juniper or ponderosa pine where timber is cut. Marked by heavier, more mesic cover, it shelters *Bufo woodhousei*, *Eumeces multivirgatus*, and some adults of *Ambystoma tigrinum*. It is distinct from the riparian association of canyon bottoms that is dominated by the narrowleaf cottonwood (*Populus angustifolia*) and various willows (*Salix* spp.) (pl. 1B). *Hyla arenicolor*, *Rana pipiens*, and *Thamnophis elegans* are more or less limited to the vicinity of streams and ephemeral ponds resulting from stream subsidence in the riparian association.

Transition from pinyon-juniper woodland into the Montane Life Belt often is gradual, especially on the north side of the Zuni Mountains and on Mount Taylor. Ponderosa pine (*Pinus ponderosa*) occurs in a few, relatively pure stands as low as 7200 feet. In the ponderosa pine association, mountain muhly (*Muhlenbergia montana*) may be the predominant ground cover. *Pituophis melanoleucus* and

Crotalus viridis were collected here as were representatives of all species found to be more abundant in pinyon-juniper, oak-mohagany, and riparian associations.

Montane Life Belt

The heavy cover characteristic of this uppermost life belt prevails above approximately 7800 feet; lower limits may be found in sheltered canyons and on north-facing slopes, where exposure is a restricting factor. The ponderosa pine association marks the lower boundary and may include Douglas fir (*Pseudotsuga menziesi*) in cooler situations. Upper limits are best developed on the higher peaks, where the spruce-fir association includes Engelmann spruce (*Picea engelmanni*) and Douglas fir along with alpine fir (*Abies lasiocarpa*) and other conifers (pl. 1C). With the exception of parks and the limited alpine tundra association on Mount Taylor, vegetation is usually too thick to permit much heating of the substrate. The soil is composed of humus covered by conifer needles. Bailey's (1913, pp. 41–51) Transition, Canadian, and Hudsonian Life Zones are included in this belt as are the coniferous forest and petran alpine biomes of Castetter (1956), petran montane and subalpine forests of Clements (1920, pp. 207–210, 224–226), and Pearson's (1931) ponderosa pine, Douglas fir, and Englemann spruce zones.

No reptiles or amphibians are restricted to this belt and none appear to reach their maximum abundance here. While 14 species were collected in montane associations, all of the reptiles except *Thamnophis elegans* came from logged-off areas or rocky openings in ponderosa pine and spruce-fir associations. *Rana pipiens*, *Bufo woodhousei*, and *Hyla arenicolor*, among others, follow the riparian association that also penetrates the Montane Life Belt. *Ambystoma tigrinum*, *Pseudacris triseriata*, *Eumeces multivirgatus*, *Phrynosoma douglassi*, and *T. elegans* were found in parks or stands of quaking aspen (*Populus tremuloides*) (pl. 1C). Only *P. douglassi* was taken in the alpine tundra association, which has no arboreal vegetation.

Recent Environmental Changes

There is little doubt that the Zuni region has suffered considerable modification within the past hundred years. The impact of man is superimposed on a record of continuous climatic change. Drought reduced the water supply and, coupled with grazing pressure, has eliminated much of the original grassland (Castetter, 1956, pp. 269, 272). Statements on the former abundance of grass were made by Bigelow (1856, p. 6), Whipple (1856, p. 62), and many others. Rothrock (1875, p. 120) described open parklike stands of ponderosa pine

with good forage at about 8000 feet near Ft. Wingate and noted that fir covered surrounding hillsides. Woodlands are now much thicker in some places and thinner or nonexistant in others because of grazing and logging, respectively (Castetter, 1956, pp. 272, 277). Correlated changes in herpetofaunal distribution may be surmized.

Surface water was more abundant prior to the twentieth century. Whipple (1856, pp. 14, 63) noted that the Zuni Indians cultivated without irrigation and described Agua Fria as a permanent spring. Kennerly (1856, pp. 9–10) observed the Zuni River as a small, clear stream in which fishes were secured at several localities. He also noted many frogs along the Rio Pescado in November. Coues (1875, pp. 614–615) found *Thamnophis elegans* in the Zuni River, "wherever this stream spread into sluggish lagoons." While seasonal changes influenced differences of opinion as to the abundance of water (e.g., in September, Sitgreaves, 1854, p. 5, described the Zuni River as a mere rivulet), it is noteworthy that Agua Fria and the lower Rio Pescado and Zuni are presently intermittent. Zuni Indians now irrigate; streams in the vicinity of their pueblo are extensively controlled.

As suggested by extensive arroyo cutting, which began in the late 1880's (Bryan, 1925, 1928), drought may account for the disappearance of surface water not purposely diverted by man. When this study was initiated, the Zuni region, indeed the entire Southwest, was in the midst of severe drought. Breeding amphibians were not collected until July 1954 and remained uncommon until 1957. *Diadophis punctatus* was not discovered at a previously worked locality (Cottonwood Gulch) until August 1959. The drought ended locally in 1957 when the Colorado Plateau Section of New Mexico received 146 percent of average annual moisture (U.S. Dept. Comm., 1945–1957). Profound changes in the neighboring Texas herpetofauna were linked to this drought (Blair, 1957; Milstead, 1960).

In 1960 the Bureau of Sport Fisheries exterminated all native aquatic organisms in the upper Zuni River (R. R. Miller, in litt.). Not a single aquatic animal depending on dissolved oxygen was left; an apparently undescribed fish, genus *Pantosteus*, was among the forms eliminated. Such wanton destruction probably will continue as the human population continues to increase. Grants experienced a 354 percent rise in population between 1950 and 1960 (Grants Chamber of Commerce, in litt.). Fortunately, however, small portions of Zuni grassland and pinyon-juniper association are preserved in El Morro National Monument and hopefully will be preserved in the proposed Manuelito National Monument.

Lava

In contrast to numerous investigations of coloration in lavicolous mammals, relatively few workers have shown similar interest in lava-dwelling amphibians and reptiles. Lewis (1949; 1951), Norris (1958, p. 270), and Lawrence and Wilhoft (1958) have demonstrated, however, the presence of abnormally dark reptiles on southwestern lava flows. Apparently selection favoring procrypsis is operating in these environments. Tertiary lava beds in the Zuni region were described adequately by Hooper (1941) and Lindsey (1951). Hooper found that mammals restricted to the malpais had not developed dark races there.

With the exception of *Uta stansburiana*, *Sceloporus graciosus*, *Masticophis flagellum*, and *Crotalus atrox*, the species characteristic of the Plains Life Belt occasionally were taken on soil-covered lava. This substrate, widespread near El Morro and Cebolleta Mesa, presents an appearance similar to the short-grass association except that it is generally higher in elevation (see Lindsey, 1951, figs. 10, 11). The Grants lava flow, on the other hand, is rough and relatively unweathered, with less soil accumulation (see Hooper, 1941, pl. 2). *Crotaphytus collaris*, *Sceloporus undulatus*, *Urosaurus ornatus*, *Eumeces obsoletus*, *Thamnophis elegans*, *Pituophis melanoleucus*, and *Crotalus viridis* were collected or observed on the rougher malpais.

Only *C. collaris*, *U. ornatus*, and *Scaphiopus hammondi* show evidence of unusually dark coloration. The latter two species are predominantly dark gray with little trace of the usual patterned dorsum. Because local populations of these species tend to resemble substrate color to a remarkable extent, it appears unlikely that the dark, lavicolous individuals represent unique variation. Lewis (1951) found dark *U. ornatus* in southern New Mexico. Three adults of *C. collaris* are patterned but are quite dark in general coloration. This is the usual situation on New Mexico lava flows (Fitch, 1956a, p. 223).

Numbers of lavicolous reptiles and amphibians were not large. While the rubble of broken lava offers uncountable hiding places, the presence of ponderosa pine and Douglas fir, postclimax to adjacent nonlava vegetation (Lindsey, 1951, p. 220), may limit the ranges of Plains species on such a substrate. Sections of sparsely vegetated malpais dominated by apache plume (*Fallugia paradoxa*) held the most reptiles, but there appeared to be easy access to and from the lava margins, with the possibility of strong immigration pressure from contiguous grassland supporting larger populations of several species. Gene flow may thus reduce the effectiveness of local selective pressures. Marginal habitats, relative accessibility, and geologic recency of the Grants malpais undoubtedly account for the fact that no indigenous dark races have developed there.

Vertical Distribution

In comparison with the Guadalupe Mountains, a region of about equal size and vertical range in southeastern New Mexico, it is evident that Zuni environmental diversity exceeds the diversity of the Zuni herpetofauna. Only 7 (33 percent) of 21 Zuni genera contain more than one species whereas 17 (41 percent) of 42 genera in the Guadalupes have two or more species (Gehlbach, in ms.). Sixty-five amphibians and reptiles currently are recorded in the Guadalupe region; only 30 definitely are known in the Zunis. This relative paucity may be influenced directly by the high elevations and climatic extremes. With increasing elevation there is a decline in the number of species (fig. 3). Such forms as *Scaphiopus bombifrons*, *Eumeces obsoletus*, and *Crotalus molossus*, near the boundary of their range in the Zunis, are restricted locally in contrast to their greater vertical distributions elsewhere.

Vertical transects from Thoreau, McKinley County, south to Cottonwood Gulch, thence to Lookout Mountain and El Morro, Valencia County (7000–9100 feet), and from Grants to Mount Taylor, Valencia County (6400–11,389 feet), were repeated in several summers (fig. 1). These, the locality records, and miscellaneous observations demonstrate that no two morphologically related species have precisely the same vertical range or relative abundance (fig. 3). This displacement pattern is especially apparent within genera but also occurs between genera if species possess similar habits (e.g., between *Holbrookia maculata* and *Phrynosoma douglassi*, or between *Masticophis taeniatus* and *Pituophis melanoleucus*). Axtell (1959, table 1) and Lowe and Zweifel (1952, fig. 4) have diagramed similar patterns in west Texas and central New Mexico respectively. The probability that two species will not be equally efficient in the same environment has been discussed by many biologists (e.g., Lack, 1949; Hutchinson, 1957).

Ecological differences were observed most readily among the Zuni lizards (table 2). Since similar differences have been correlated with morphological variation (Collette, 1961; Lundelius, 1957) and thermoregulation (Bogert, 1949; Fitch, 1956b), the presence or absence of such correlations may help to elucidate local ecological segregation. *Sceloporus undulatus*, *S. graciosus*, *Urosaurus ornatus*, *Phrynosoma douglassi*, *Eumeces multivirgatus*, and *Cnemidophorus velox* are of similar size; hence, presumably they are able to capture similar-sized prey. Attention is focused on these species with particular reference to the number of lamellae as an index to climbing ability (Collette, 1961).

Of the iguanids, *U. ornatus* shows the greatest climbing propensities and has the most lamellae in proportion to size (cf. table 2; fig. 4).

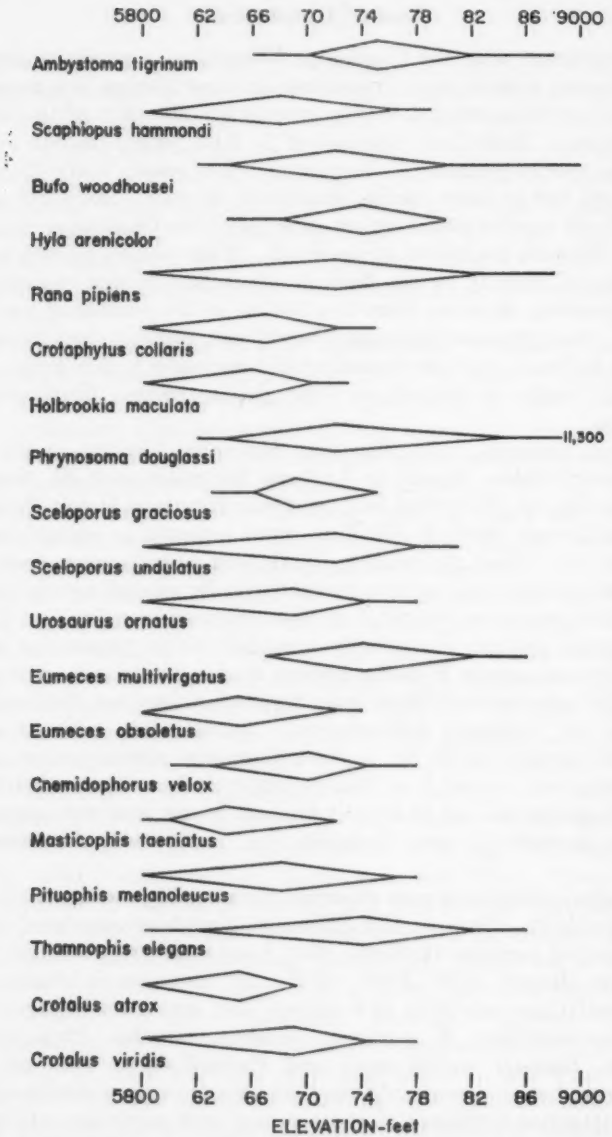


FIGURE 3.—Schematic vertical distribution and relative abundance of some amphibians and reptiles in the Zuni region. (The horizontal line indicates marginal occurrence; the widest part of each polygon is the approximate elevation of greatest abundance irrespective of habitat considerations noted in the text.)

Its elevational range is about equal to that of *S. undulatus*, but the two species are separated ecologically in all life belts. As suggested by its fewer lamellae, *S. undulatus* is primarily terrestrial, while *U. ornatus* is distinctly scansorial and saxicolous. At the same locality *S. undulatus* is found on the ground or on fallen or leaning tree trunks (rarely on vertical trunks), and *U. ornatus* inhabits rock outcrops, boulder piles, and cliffs. *U. ornatus* maintains body temperatures that are two to three degrees higher than *S. undulatus* or *S. graciosus* (P. Licht, in litt.). It frequents situations with greater exposure (table 2).

TABLE 2.—*Niche relationships of adult lizards in the Zuni region (species are arranged from most scansorial to most terrestrial, top to bottom of table)*

Shade	Partial shade	Sun
		Urosaurus ornatus
	Sceloporus undulatus	*Crotaphytus collaris*
	Sceloporus graciosus	*Cnemidophorus velox*
	Eumeces obsoletus	*Holbrookia maculata*
Eumeces multivirgatus	*Phrynosoma douglassi*	

S. graciosus also is predominantly terrestrial and does not occur in ecological sympatry with *U. ornatus*. It has more lamellae than *S. undulatus* and fewer than *U. ornatus;* its vertical range and center of abundance are quite different (fig. 3). *S. graciosus* was found only in the vicinity of big sagebrush or saltbush on loose soil. In contrast, *S. undulatus* rarely was seen on such a substrate and was taken commonly on hard-packed clay or broken sandstone in the pinyon-juniper savanna. While these edaphic factors may separate partially the two species of *Sceloporus*, marked terrestrialism in *S. graciosus* belies the obvious adaptive significance of having more lamellae. This character actually may have little to do with local ecological segregation, or it could permit more effective locomotion on loose soils.

P. douglassi has the lowest lamellae count among the iguanids considered here and is characteristically the most terrestrial (table 2; fig. 4). Although the two species of *Sceloporus* sometimes climb in rock-piles, bushes, and trees, *P. douglassi* was never observed off the ground. It has the greatest elevational range of any species in the Zunis and is more sedentary in habit and more abundant above 7200 feet (fig. 3). The vertical distribution and lamellae count of *E. multivirgatus* are most like those of *P. douglassi*; however, this skink typically inhabits dense vegetative cover (table 2). Bogert (1949) and Fitch (1956b) have shown that low body temperatures are more typical of *Eumeces* than either *Sceloporus* or *Cnemidophorus*.

The very high lamellae count of *C. velox* apparently is unrelated to scansorial ability, for this teiid rarely climbs. Instead, might the lamellae count be correlated with a longer toe, as Hecht (1952, p. 116) has suggested in other lizards? The number of lamellae cannot be used as an index of relative climbing ability here; its inapplicability

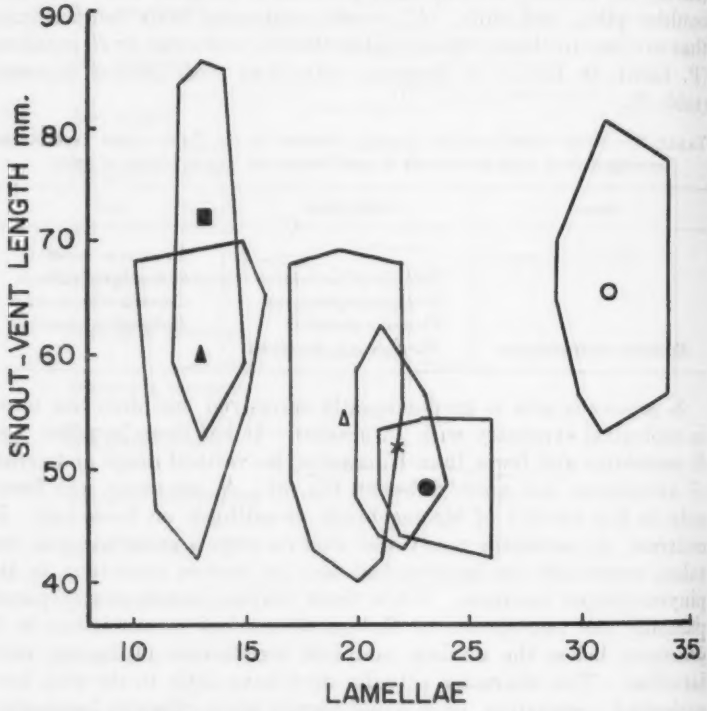
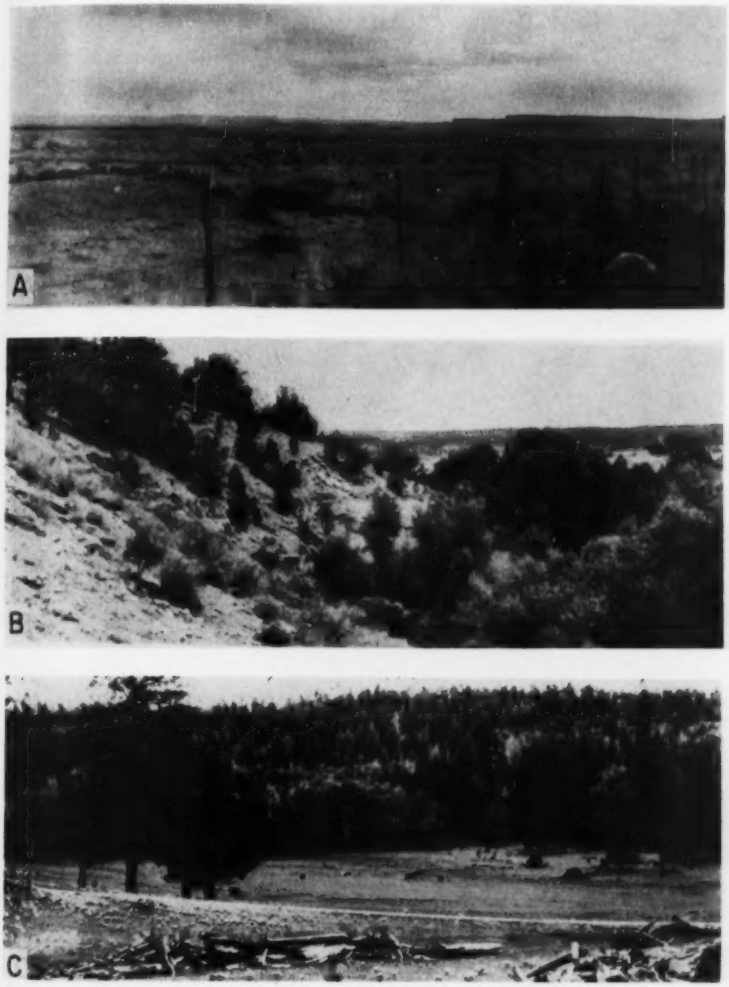


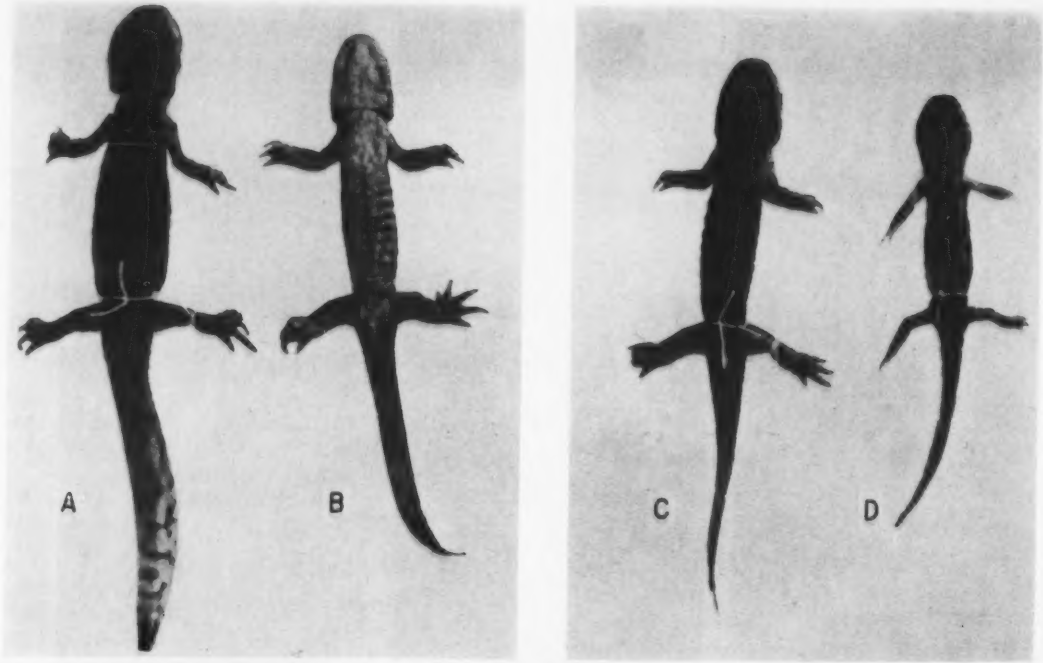
FIGURE 4.—Relationship of the number of fourth-toe lamellae to snout-vent length in adults of some Zuni lizards. (Outside limits of the plotted points are joined to form polygons representing each species. Means are indicated by position of the symbols.)

■ *Phrynosoma douglassi*
▲ *Eumeces multivirgatus*
△ *Sceloporus undulatus*
× *Sceloporus graciosus*
● *Urosaurus ornatus*
○ *Cnemidophorus velox*

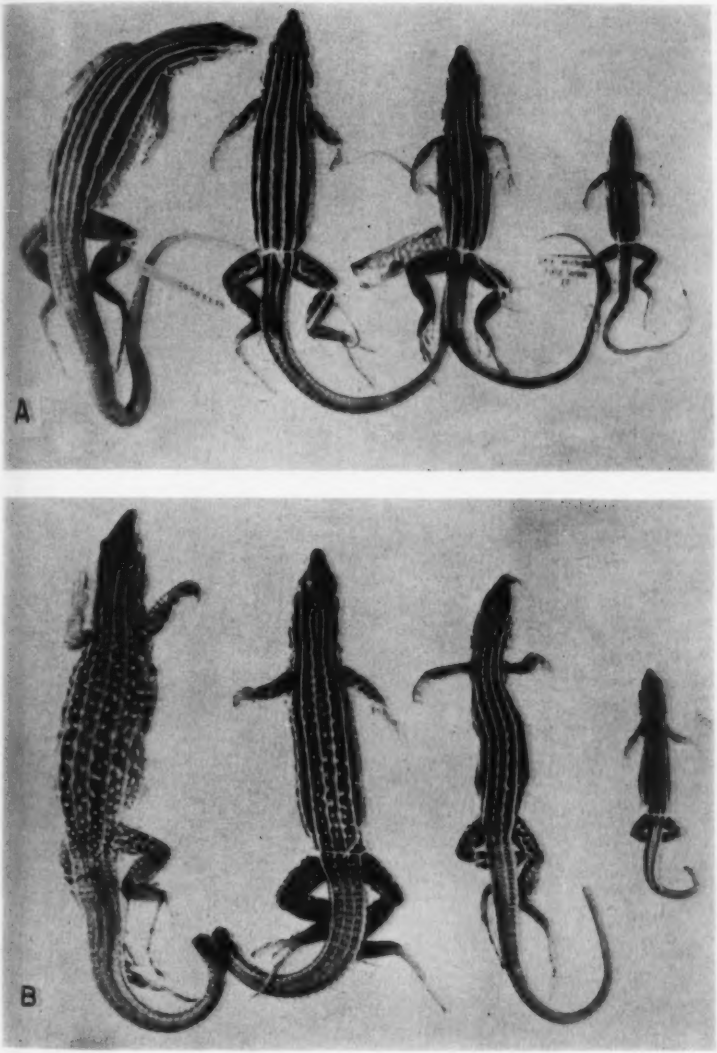
with respect to the observed intergeneric differences is apparent (fig. 4). Ecological separation is indicated, however; *C. velox* inhabits areas of greater insolation than the other nonclimbing species (table 2). Its congeners maintain much higher body temperatures than the other genera studied (Bogert, 1949; Fitch, 1956b).



A, Short-grass association of the Plains Life Belt near Laguna, Valencia County, New Mexico, ca. 5700 feet, June 1957; B, Roughlands Life Belt at Cottonwood Gulch, McKinley County, New Mexico, ca. 7200 feet, June 1957 (the hillside supports pinyon-juniper association with riparian association on the right); C, Montane Life Belt at Ojo Redondo, Valencia County, New Mexico, ca. 8600 feet, July 1954 (a natural park in the foreground is surrounded by spruce-fir association perforated by aspen stands).



Ambystoma tigrinum nebulosum from the Zuni region: A, dorsum of UMMZ 120301, adult male, 102 mm. snout-vent, without yellow spots; B, venter of UMMZ 120305, adult female, 87 mm. snout-vent; C, dorsum of UMMZ 120305, adult female, 81 mm. snout-vent, with yellow spots; D, dorsum of UMMZ 120305, subadult, 60 mm. snout-vent, with yellow reticulated pattern.



A, Ontogenetic series of *Cnemidophorus velox* (UMMZ 120288–89, 120309) from the Zuni region: snout-vent lengths from left to right are 80, 70, 61, and 36 mm.; note the absence of spots, also the complete middorsal light stripe on the left followed by a specimen lacking this stripe and two with incomplete stripes. B, Ontogenetic series of *Cnemidophorus exsanguis* (UMMZ 79212, 15052, 102729–30) from Grant County, New Mexico: snout-vent lengths from left to right are 87, 81, 65, and 39 mm.; note the gradual appearance of spots.

Diadophis punctatus regalis from six miles south of Thoreau, McKinley County, New Mexico. The specimen (UMMZ 122947) is an adult male, 478 mm. in total length.

Accounts of Species

Adult specimens of Zuni amphibians and reptiles that have been critically examined number about 700. Many more larval amphibians and collections from outside areas also have been studied. Meristic, morphometric, and color-pattern variations are analyzed according to taxonomic criteria set forth by the latest revisers. These criteria are recognizably different, depending on the student of the group (Pimentel, 1958). Their value, in certain cases, may be challenged. In addition, novel characters are described and evaluated with particular regard for environmental and ontogenetic variation.

For most species, a brief, locally pertinent, nomenclatorial history is followed by taxonomic analysis, data on life history, and a summary of ecological distribution. A more penetrating taxonomic account is included for *Ambystoma tigrinum*, *Cnemidophorus velox*, and *Diadophis punctatus* in view of certain problems that exist. Less space is devoted to some species because other workers are utilizing Zuni material or because few specimens or observations actually are available.

Locality records refer to the Zuni herpetofauna exclusively. Most of these records are based on specimens examined, but a few, indicated by asterisks, represent museum data supplied by colleagues. Comparative material examined includes only those extralimital specimens used in figures and tables or specifically referred to in the separate accounts and not given full provenance data in these discussions. In some cases newer maps permit more accurate mileages and elevations than previously published by Chenoweth (1950), Gehlbach (1956), and Hooper (1941); however, the Zuni region remains to be thoroughly surveyed.

Museum specimens are denoted by the following abbreviations:

AMNH	American Museum of Natural History, New York, N.Y.
ANSP	Academy of Natural Sciences, Philadelphia, Pa.
BCB	Bryce C. Brown (private collection), Waco, Tex.
BYU	Brigham Young University, Provo, Utah
CCNP	Carlsbad Caverns National Park, Carlsbad, N.M.
CNHM	Chicago Natural History Museum, Chicago, Ill.
CU	Cornell University, Ithaca, N.Y.
CWGF	Cottonwood Gulch Foundation, Thoreau, N.M.
ISM	Illinois State Museum, Springfield, Ill.
KUMNH	Kansas University, Museum of Natural History, Lawrence, Kans.
LMK	Laurence M. Klauber (private collection), San Diego, Calif.
MCZ	Museum of Comparative Zoology, Harvard Univ., Cambridge, Mass.
MVZ	Museum of Vertebrate Zoology, Univ. of California, Berkeley, Calif.
TNHC	University of Texas Natural History Collection, Austin, Tex.
UCM	University of Colorado Museum, Boulder, Colo.

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Diadophis punctatus regalis from six miles south of Thoreau, McKinley County, New Mexico. The specimen (UMMZ 122947) is an adult male, 478 mm. in total length.

UIMNH	University of Illinois, Museum of Natural History, Urbana, Ill.
UMMZ	University of Michigan, Museum of Zoology, Ann Arbor, Mich.
UNMCV	University of New Mexico, Collection of Vertebrates, Albuquerque, N.M.
USNM	United States National Museum, Washington, D.C.

Class Amphibia: Order Caudata

Ambystoma tigrinum nebulosum Hallowell

The subspecific status of tiger salamanders on the Colorado Plateau and in adjacent areas has been interpreted variously. Allocation of Zuni specimens was left in doubt by Dunn (1940, p. 162). Bishop (1943) and Stebbins (1951; 1954) included the Zunis within the range of *A. t. nebulosum*, possibly because some of Dunn's specimens resembled material from Utah and Colorado then known as *A. t. nebulosum* through confusion of type locality. Lowe (1955d, p. 244) correctly reassigned the name *nebulosum* to *A. tigrinum* of the Mogollon Plateau and vicinity. But as evidence now indicates, Lowe (1955d, p. 247) inadvertently confused the status of Colorado Plateau populations by describing *A. t. utahense* from this region.

Adult specimens, above 80 mm. snout-vent length, of *A. tigrinum* from the Zunis have relatively longer tails in larger individuals, especially the males (fig. 5). With two exceptions, their color pattern consists of yellow spots or reticulations on a brownish to black ground (pl. 2C). Five adults have reticulate patterns and five subadults, 60–73 mm. snout-vent, resemble them (pl. 2D). In 15 other adults the number of dorsal spots between extremes of limb insertions ranges from 11 to 50 ($\bar{x}$ 30.8±2.8); tail spots number 8 to 37 (13.0±2.9). These resemble *A. t. stebbinsi* on the basis of dorsal spots but are closer to *A. t. nebulosum* as regards tail spots (cf. Lowe, 1955d). When compared to the topotypic *A. t. nebulosum* described by Lowe (1955d, table 1), the Zuni salamanders average more dorsal body spots and fewer tail blotches. Their venters are mottled as in *A. t. nebulosum* or variously suffused with dark pigment as in *A. t. stebbinsi* or *A. t. utahense* (pl. 2B; cf. Lowe, 1955d, figs. 4A, C, 5A). They are as distinct from topotypic *A. t. nebulosum* as *A. t. stebbinsi* is and combine the diagnostic features of both races. I suggest that *A. t. stebbinsi* belongs in the synonymy of *A. t. nebulosum*.

In contrast to the specimens described above, one adult male (KUMNH 45762, 95 mm. snout-vent) is much darker in general aspect, with dorsal spots reduced to minute points of dull yellow, although the tail spots are plainly indicated. Another large, dark male is olive brown with irregular black body markings and light-olive tail spots (pl. 2A). These specimens resemble *A. t. utahense* or *A. t. utahense* x *nebulosum*, as does a similar specimen from San

Francisco Mountain, Coconino County, Arizona, the type locality of *A. t. nebulosum* (see Hallowell, 1854, p. 144).

Evidence from other Colorado Plateau localities coupled with the Zuni data suggests that *A. t. utahense* is an ontogenetic variant of *A. t. nebulosum*. Lowe's statement (1955d, p. 238) that adult color

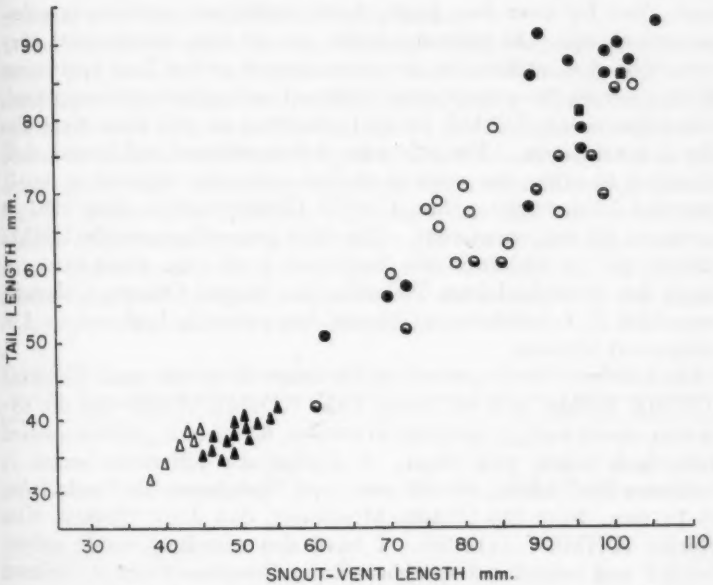

FIGURE 5.—Relationship of tail length to snout-vent length in *Ambystoma tigrinum nebulosum* from the Zuni region.

● Males, metamorphosed
◒ Females, metamorphosed } Yellow-spotted
○ Larvae

■ Males, metamorphosed } Non-yellow-spotted

▲ Metamorphosed
△ Larvae } Experimentally maintained (collected July 16, 1957, 7800 feet)

pattern is established upon transformation, unfortunately, is misleading. Dunn (1940, p. 154) and Bishop (1941, p. 163) have summarized ontogenetic changes in color pattern with which I concur. In fact, Dunn (1940, p. 158) diagnosed *A. t. nebulosum* (=*A. t. utahense*, Lowe, 1955d) as containing yellow-spotted young and

non-yellow-spotted adults. It is significant that recently transformed Zuni specimens, like certain larvae, are olive brown above with small scattered dark spots and some lemon-yellow mottling on the tail, thus approximating *A. t. nebulosum* figured by Bishop (1943, fig. 45: 1, 2). Only later do they develop the yellow spotting characteristic of subadults.

Two individuals from Molas Lake, San Juan County, Colorado, kept alive for over two years, have undergone continuous color-pattern change. At metamorphosis (ca. 65 mm. snout-vent) they resembled *A. t. utahense* in the same manner as the Zuni specimens. Within a week the ground color darkened and yellow spots appeared. Other specimens (UMMZ 121925) preserved at this time were also like *A. t. nebulosum*. The yellow spots then enlarged and became dull, changing to olive; the original ground color was reduced to small, irregular black marks. One (UMMZ 122526) died in May 1961; it measures 101 mm. snout-vent. The other presently resembles UMMZ 120301 (see pl. 2A) from the Zunis and is 96 mm. snout-vent. A single live individual from Telluride, San Miguel County, Colorado, resembled *A. t. nebulosum* at 70 mm. but currently is closest to *A. t. utahense* at 105 mm.

Dark-brown, black-spotted adults taken in ponds near Telluride (UMMZ 120304) and at Molas Lake (UMMZ 121926–29) are 81–98 mm. snout-vent, in contrast to smaller, 63–69 mm., yellow-spotted individuals taken with them. A similar size difference occurs in "*utahense*-like" adults, 92–107 mm., and "*nebulosum*-like" subadults, 68–73 mm., from the Chuska Mountains, San Juan County, New Mexico (UNMCV 1111–21). I have also examined small yellow-spotted and reticulated specimens from Coconino County, Arizona (UMMZ 120302), and San Juan County, Utah (UMMZ 121931). This rough correlation of size and coloration favors the hypothesis of ontogenetic change. Sexual pattern dimorphism is absent; however, relative size at metamorphosis may influence color pattern (see below). Since *A. t. utahense* as defined by Lowe (1955d, pp. 246–247) is based apparently on ontogenetic variation in *A. t. nebulosum*, it is suggested that this name also be placed in the synonymy of *A. t. nebulosum*.

Color-pattern comparisons of larvae, 35–65 mm. snout-vent, from the Colorado Plateau and adjacent areas reveal no basic geographic differences. The coloration described by Stebbins (1951, p. 46), however, may vary locally as regards density of spotting and shade of ground color; for example, the specimens from Catron County, New Mexico (UNMCV 1163–68), are heavily spotted or mottled with brown and black. The tail fin has black edges, and the lateral light line or row of light spots is nearly indistinct. In contrast, specimens from

Bernalillo County (UNMCV 1138–61) are very light with little hint of spotting. It is apparent that larvae from shallow, well-illuminated pools are lighter in color than those from deeper, darker environments. Very large larvae are usually greenish, olive, or brown, with widely spaced black spots. They often lack light and dark mottling and a lateral light line. Coues (1875, p. 633) described this *"Siredon"* or axolotl coloration in specimens from Jacob's Well, Apache County, Arizona, and from San Francisco Mountain.

The number of gill rakers provides structural evidence that larvae from the Colorado Plateau, southern Arizona, Wyoming, and other localities in New Mexico are very similar (table 3). Northern Arizona specimens have somewhat fewer gill rakers, but this appears to be local variation since larvae from Telluride, Colorado, resemble them yet are geographically closer to populations with more rakers, e.g., Molas Lake. Larvae from Michigan (*A. t. tigrinum*) and San Luis Potosi, Mexico (*A. t. velasci*), also have fewer gill rakers and approach the reduced number characteristic of *Ambystoma rosaceum* in this respect. Further study of larval characters should aid in clarifying the status of other subspecies of tiger salamanders.

TABLE 3.—*Frequency distribution of gill rakers on the anterior face of the third gill arch in larvae (35–65 mm. snout-vent) of* Ambystoma tigrinum *and* A. rosaceum

	Gill rakers														
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	N	x̄
A. rosaceum																
Durango, Laguna del Progresso	3	5	1												9	10.8
Durango, 2.5 mi. W. San Luis	2	5	2												9	11.0
Sonora, El Tigre Mountains		2	5	2	1										10	12.2
A. tigrinum																
San Luis Potosi, San Diego							1	6	2	1					10	17.3
Michigan, Ann Arbor								2	6	2	1				10	18.3
Arizona, Hauchues Mountains										2	2	4	2		10	20.6
New Mexico, 9 mi. E. Mogollon										1	2	2	1	1	7	20.9
New Mexico, Zuni region										4	7	2	2	1	16	20.3
New Mexico, 10 mi. S. Albuquerque											3	4	2	1	10	21.1
New Mexico, Sandia Park										2	3	2	1	1	9	20.5
New Mexico, Pecos									1	3	1	4		1	10	20.2
Arizona, Wheatfield Creek									1	3	1	2			7	19.6
Arizona, Grand Canyon								1	2	3	3	1			10	19.1
Colorado, 9 mi. SW. Telluride									2	2	5	1			10	19.5
Colorado, Molas Lake										2	1	6	1		10	20.6
Wyoming, Hoback Basin										2	2	2	4		10	20.8

In the Zunis, larvae and adults of *A. t. nebulosum* usually were found in temporary potholes and canyon-bottom pools. Larvae were collected in cattle tanks on Mount Taylor in 1959, and S. W. Woodhouse (1854, p. 35) reported *Siredon lichenoides* (=large larvae of *A. tigrinum*) in a spring near the Zuni Pueblo. Although suitable habitats were investigated repeatedly throughout the present study, larvae were not discovered until July 1957, when the unusually heavy rainfall produced

great amounts of surface water. Prior to that time, one active adult was dug from moist ground in the riparian association at a depth of six feet during excavations for a swimming pool.

One hundred and fifty-three larvae, similar in coloration to that described by Stebbins (1951, p. 46) from near Flagstaff, Arizona, were seined from a pothole approximately 10 feet in diameter on July 16, 1957, at 7800 feet. Of these, 36 measured 35–45 ($\bar{x}$ 42.2) mm. snout-vent, 32–39 (35.8) mm. tail length. In the laboratory, 25 were kept for 28 days, 5 to a gallon jar. At the end of this period, 5 specimens had died, 14 had fully transformed, and 6 still possessed well-developed gills and larval body form. Body proportions of these specimens reveal greater size in the recently metamorphosed individuals (fig. 5). During captivity the larvae continuously gulped air at the water surface, something they had not been doing when collected.

On July 27, 1957, larvae equal in size to those previously captured at 7800 feet were taken from an arroyo 500 feet lower at the mouth of the same canyon and nearly one mile distant. A week of heavy rain that flooded the first locality filled the previously dry arroyo and presumably carried larvae to the new locality.

Five large larvae and one adult were collected in the pothole at 7800 feet, July 3, 1958, prior to the onset of heavy summer rainfall. The pond was 15 feet wider at this time than previously. About 20 other *A. tigrinum* of similar size could be seen surfacing and gulping air. The majority of these had normal larval gills and body form, but several had reduced gills. No other adults were observed although several were taken in ponds later in the summer. The collected larvae were light olive green dorsally with scattered dark spots. Two transforming specimens had light lateral reticulations on the tail; their venters were unmarked. These five larvae and six others from a pool at 7000 feet are of similar coloration and proportions. They have relatively longer tails than transformed specimens of similar body size (fig. 5).

The above data suggest that larval development requires at least two years in some populations of *A. t. nebulosum* in the Zunis. First proposed by Burger (1950b), this life history pattern does not apply necessarily to all Zuni larvae, for shallow pools at 7300 feet examined July 3, 1958, contained small larvae similar in size to the first-year individuals taken in 1957. Spatial isolation of larval size groups is not surprising when one considers the predacious nature of these salamanders. The tadpoles of *Hyla arenicolor* and *Bufo woodhousei*, although abundant in the area, rarely were found in the same pools with *A. tigrinum*. Food habits of tiger salamander larvae during the anuran breeding season demonstrate why this is so (fig. 6).

That paedogenesis occurs in larger Zuni larvae is evidenced by the fact that at least one specimen (USNM 8240, 103 mm. snout-vent) contains many large yolked eggs. Environmental factors believed to cause neoteny in *A. tigrinum* have been widely reviewed. In the present study, transformation, both natural and experimentally tested, seemed to be initiated by shrinkage of the pond environment associated with increased temperatures and decreased oxygen supply.

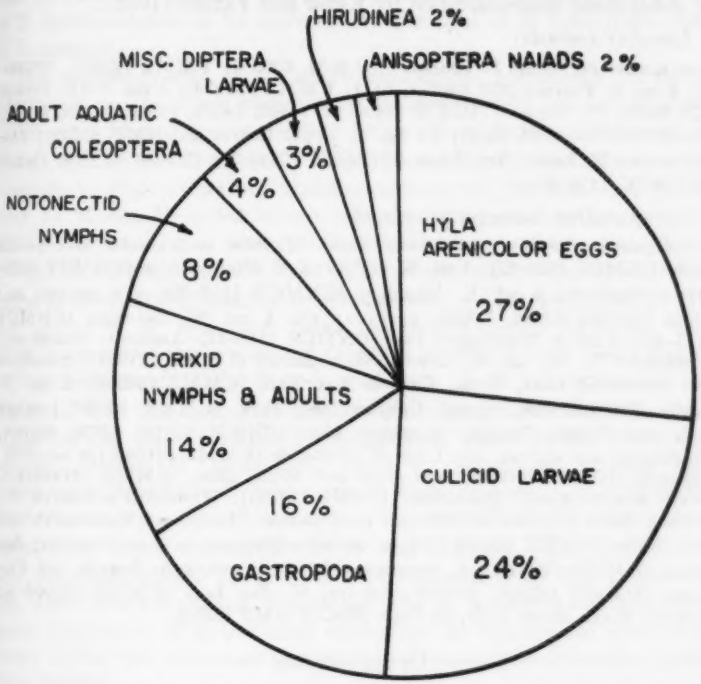

FIGURE 6.—Food (in percent of volume) of 36 larvae of *Ambystoma tigrinum nebulosum*, 35–45 mm. in snout-vent length, collected July 16, 1957, at 7800 feet.

Shufeldt (1885) cited similar evidence for metamorphosis in Zuni larvae as did Durham (1956, p. 220) for *A. tigrinum* from northern Arizona. Schuierer (1958) said that, among other things, a well oxygenated, constant water supply was implicated in maintaining neoteny.

Most Zuni larvae forced to gulp air at the surface in laboratory jars metamorphosed within four weeks of capture regardless of size. Specimens under similar conditions remained larval in form when provided with an artificial oxygen supply. Some larvae, approxi-

mately 50 mm. snout-vent, in an exposed, rapidly evaporating pool, transformed during a 59-day observation period in 1959. Another group of similar size located under a ledge in a nearby pool showed little reduction of larval features during this time. Thus, *A. tigrinum* in the Zunis may remain larval and become paedogenic if provided with a relatively permanent aquatic environment but can transform under arid conditions. Such ecotypic plasticity also has been noted in *Ambystoma macrodactylum* by Kezer and Farner (1955).

Locality records:

MCKINLEY CO.: 6 mi. S. Thoreau (CU 6234, 6303–4; UMMZ 120301, 120305–6); 8 mi. S. Thoreau (CU 6301–2, 6411; UMMZ 122929); 4 mi. NNE. Prewitt (CU 6307); Ft. Wingate (USNM 14409–12, 14402, 14633, 14490, 14818, 19118); Nutria (USNM 8240, 8456); 2.5 mi. N. Upper Nutria (KUNMH 45762); VALENCIA CO.: El Morro Nat. Mon. (KUMNH 15556–7); 17.5–18 mi. NE. Grants (UNMCV 1122–28).

Comparative material examined:

Ambystoma tigrinum nebulosum.—NEW MEXICO: BERNALILLO CO.: Sandia Park (UNMCV 1129–37); 1 mi. W. and 10 mi. S. Alburquerque (UNMCV 1138–61); CATRON CO.: 9 mi. E. Mogollon (UNMCV 1163–68); SAN MIGUEL CO.: Pecos (UMMZ 67886, 71383); SAN JUAN CO.: 5 mi. W. Toadlena (UNMCV 1111–13); 2 mi. S. Washington Pass (UNMCV 1119–21); ARIZONA: APACHE CO.: Wheatfield Cr., 0.5. mi. W. Ariz.-N. M. boundary (UMMZ 121932); COCONINO CO.: Greenland Lake, Grand Canyon Nat. Park (UMMZ 120302); 2. mi. N. North Rim entrance, Grand Canyon Nat. Park (UMMZ 120303); SANTA CRUZ CO.: Parker Canyon, Huachuca Mts. (CNHM 62616, 62638, 62640); COLORADO: SAN MIGUEL CO.: 1 mi. W. Telluride (UMMZ 121943); 9 mi. SSW. Telluride (UMMZ 120304); SAN JUAN CO.: Molas Lake (UMMZ 121923–29); UTAH: SAN JUAN CO.: Monticello (UMMZ 121931); WYOMING: SUBLETTE CO.: Hoback Basin (UMMZ 99751). *A. t. tigrinum*.—MICHIGAN: WASHTENAW CO.: Ann Arbor (UMMZ 69648). *A. t. velasci*.—MEXICO: SAN LUIS POTOSI: San Diego (UMMZ 77331). *A. rosaceum*.—MEXICO: DURANGO: Laguna del Progresso (UMMZ 102528, 110902); 2.5 mi. W. San Luis (UMMZ 110903–4); SONORA: Santa Maria Mine, El Tigre Mts. (UMMZ 78353).[3]

Order Anura

Scaphiopus hammondi Baird, *S. intermontanus* Cope, and *S. bombifrons* Cope

Members of the subgenus *Spea* of *Scaphiopus* have been treated differently with respect to specific status. Linsdale (1940, p. 200), VanDenburgh (1924, p. 194), and Wright and Wright (1949, pp. 112–120) considered *S. intermontanus* and *S. bombifrons* to be races of *S. hammondi*, an arrangement first proposed by Cope (1889). *S. intermontanus* was placed as the northern subspecies of *S. hammondi*,

[3] These larvae were reported as *A. tigrinum* by Stebbins (1951, p. 40, pl. 52) but apparently they are *A. rosaceum* because of their striking light- and dark-reticulated pattern (unlike any *tigrinum* known to me) and because of their fewer gill rakers (table 3).

and *S. bombifrons* was considered a distinct species by Schmidt (1953, p. 59) and Stebbins (1951, pp. 202–218; 1954, pp. 92–94). Stejneger and Barbour (1943, pp. 37–39), Tanner (1939), and Zweifel (1956) separated the three forms as species, an arrangement which I favor on the basis of available Zuni material. I further concur with Zweifel (1956, p. 37) in suggesting that *S. bombifrons* and *S. intermontanus* may be conspecific. Blair (1956) thought the call of *S. intermontanus* to be more nearly like that of *S. bombifrons* than *S. hammondi*.

The measurements of 41 adult spadefoots, considered to be *S. hammondi* on the basis of flattened frontoparietals, are summarized (table 4). Males are somewhat larger than females as noted in *S. holbrooki* by Pearson (1955). Such sexual dimorphism is frequently reversed in other anurans. Specimens from the Miocene lava plains near El Morro National Monument are larger and darker in color than those from light, sandy soils near Thoreau and Grants. When compared with individuals from other southwestern states, the total series is considerably smaller in all respects (see Tanner, 1939, p. 17). All adults of *S. hammondi* have red-tipped dorsal tubercles, and most have small dark spots or blotches scattered over the dorsum.

Four adults of *S. bombifrons* and two of *S. intermontanus* are distinct when one considers relative elevation of the frontoparietal bones as the best criterion for separation (see Zweifel, 1956, pp. 35–37). Unlike *S. hammondi*, these six specimens possess two continuous dorsolateral light stripes that diverge posterolaterally from the occiput. The *S. bombifrons* measure 48, 49, 50, and 52 mm. snout-vent; the *S. intermontanus*, 46 and 51 mm. These individuals are, therefore, larger than most *S. hammondi* from the Zunis. A size difference between *S. hammondi* and *S. bombifrons-S. intermontanus* may serve as an isolating mechanism in this area of sympatry. Lowe (1954) has discussed this factor in *Scaphiopus* of south-central New Mexico.

S. intermontanus is recorded here from New Mexico for the first time. The specimens were taken at 7200 feet in an area of mixed grass and one-seed junipers. The present localities for *S. bombifrons*, at 6400 to 7200 feet in the Plains Life Belt, are near the extreme northern limit of its range in New Mexico; hence, an ideal situation for studying the relationships of *S. bombifrons* and *S. intermontanus* exists in the Zunis. Conclusive evidence that these two species are isolated reproductively rests with the collection of additional material in this critical area.

The spawning of *S. hammondi* in rainpools, cattle tanks, roadside ditches, and canyon-bottom potholes was observed during periods of heavy rainfall in July and August. Breeding sites were located in

TABLE 4.—*Measurements in mm. (range and mean) of some Zuni anurans*

Species	N	Snout-vent length	Head length	Femur length	Tibia length	Hindfoot length
Scaphiopus hammondi [1] (♂)	16	38–47(42.2)	13–15(13.7)	17–21(18.5)	13–16(14.6)	15–18(16.7)
" " (♀)	8	40–45(41.9)	13–15(13.6)	18–20(18.6)	13–15(14.4)	14–16(15.3)
Scaphiopus hammondi [2] (♂)	11	44–53(47.2)	14–15(14.7)	20–23(20.9)	15–18(16.1)	17–19(17.9)
" " (♀)	6	36–46(42.0)	13–15(13.8)	16–21(19.3)	13–16(14.8)	13–17(15.4)
Bufo woodhousei (♂)	14	80–96(86.9)	18–20(18.8)	29–45(36.4)	30–38(34.2)	32–43(39.5)
" " (♀)	8	65–101(80.9)	13–22(17.7)	30–45(35.1)	26–41(31.6)	27–45(34.8)
Hyla arenicolor (♂)	9	40–49(43.8)	12–15(13.0)	19–24(21.5)	19–23(20.5)	17–21(18.2)
Rana pipiens (♂)	9	38–52(46.1)	14–19(16.4)	19–25(21.5)	20–31(25.4)	21–38(26.6)

[1] From 15 mi. E. Grants, Valencia County, New Mexico.

[2] From El Morro National Monument, Valencia County, New Mexico.

all major vegetational associations below the spruce-fir, but western spadefoots were most abundant in the pinyon-juniper savanna and Plains-Roughlands continuum. The earliest observed egg-laying occurred July 4, 1954, at 6400 feet in a small tank on the eastern soil-covered edge of the Grants malpais; the air temperature was 48° F., water 53° F., at 9:30 p.m.

In the choruses of *S. hammondi*, most vocal males swam or floated in the middle of the pond, but several called from shallow water or shore. *S. bombifrons* and *S. intermontanus* were not taken in breeding aggregations. They may breed earlier in the season here as *S. intermontanus* does in Utah (Blair, 1956). This could explain the shore-calling station of *S. hammondi* in view of its apparent preference for a swimming-floating position when in reproductive sympatry with other spadefoots (Gehlbach, 1956, p. 365; McAlister, 1959).

The larvae of *S. hammondi* commonly occurred with tadpoles of *Hyla arenicolor* and *Bufo woodhousei* in the riparian association of the Roughlands Life Belt. They were found only with *Bufo punctatus* in cholla-juniper grassland and without anuran associates in the short-grass association. On July 3, 1959, cannibalistic larvae of *S. hammondi* with hypertrophied jaw muscles and beaked upper mandibles were collected at 7700 feet in pinyon-juniper-ponderosa ecotone. They were located with typical larvae in a rainpool four inches deep and two by six feet in outside dimensions. The water temperature was 75° F., air 83° F., at 11:20 a.m. A single dip net sample held 15 cannibalistic (6–13, $\bar{x}$ 10.9 mm. body length) and 6 typical (16–18, $\bar{x}$ 17.4 mm.) specimens, the former with hindlimb buds, the latter with larger hindlimbs and toes. Seven recently transformed *Scaphiopus* species, taken at 6900 feet, September 1925, by Neil M. Judd, measure 16–22 ($\bar{x}$ 18.6) mm. snout-vent.

Locality records:

S. hammondi.—MCKINLEY CO.: 6 mi. S. Thoreau (CU 6309; UMMZ 120300); 8 mi. S. Thoreau (CU 6476; UMMZ 120308); Thoreau (USNM 70412–21); 16 mi. S. Gallup (CU 6231); VALENCIA CO.: 15 mi. E. Grants (KUMNH 14547–66, 14569–72); 11.5 mi. SSE. Grants (CU 5775); El Morro Nat. Mon. (KUMNH 14538–46, 17271–8). *S. bombifrons*.—MCKINLEY CO.: 16 mi. S. Gallup (CU 6310); VALENCIA CO.: Grants (KUMNH 14568); El Morro Nat. Mon. (KUMNH 17222–3). *S. intermontanus*.—VALENCIA CO.: 2 mi. W. El Morro Nat. Mon. (CU 6308).

Bufo punctatus Baird

This red-spotted toad is known from only two localities in the Zuni region. It apparently does not breed above 6800 feet, for intensive search has not revealed its presence in numerous anuran choruses in or above the pinyon-juniper association. Thus, it is somewhat ecologically separated from *Bufo woodhousei*, which is most abundant above 7000 feet (fig. 3). *B. punctatus* may be common in the cholla-

juniper grassland and Plains-Roughlands continuum around Grants. A single chorus observed at 6400 feet, July 4, 1954, after a heavy rain, consisted of more than 100 calling males in a small cattle tank on soil-covered lava adjacent to the rough Grants malpais (Gehlbach, 1956, p. 365). *Scaphiopus hammondi* was present in about equal numbers in the breeding aggregation.

Locality records:

VALENCIA CO.: 11.5 mi. SSE. Grants (CU 5766); Grants (Smith, 1950, fig. 45).

Bufo woodhousei woodhousei Girard x *B. w. australis* Shannon and Lowe

Rocky Mountains toads in Arizona recently have been split into two races (Shannon and Lowe, 1955). The nominate, northern subspecies is now considered to occupy the Colorado Plateau in that state; it is separated presumably from a new southern, lowland form, *B. w. australis*, by the Mogollon Plateau. Shannon and Lowe (1955, pp. 188, 190) included New Mexico within the range of *B. w. australis* but did not state specific localities. *B. woodhousei* from the Zuni region does not conform readily to either subspecies. Geographically these toads might be expected to resemble typical *B. woodhousei*, but structurally they combine some characters of *B. w. australis* with *B. w. woodhousei* and are considered intergrades.

With regard to diagnostic features, 22 adult specimens have: (1) frontal area of cranium elevated in 91 percent; (2) snout-vent length/parotoid gland width 10.6–13.9 ($\bar{x}$ 11.9$\pm$0.19); (3) snout-vent length/parotoid gland length 4.4–5.6 (5.1$\pm$0.74); (4) skin of upper surfaces smooth; (5) median white line on snout present in 82 percent; (6) black pectoral semicircles not strongly developed; (7) dorsal color brown with 68 percent having large warts set in black. Characters 1, 2, 4, 5, and 6 favor allocation with *B. w. woodhousei*, while 3 and 7 are closer to *B. w. australis*.

Colorado Plateau populations of *B. woodhousei* should be more or less uniform in the Zunis and adjacent Arizona since no important barriers to east-west dispersal exist. Such continuity is shown, for the characters of *B. w. woodhousei* predominate in the specimens at hand. The features of *B. w. australis*, however, indicate that gene flow from the south occurs if, in fact, these features are sufficient to distinguish *B. w. australis* from the nominate form in New Mexico. Irrespective of the validity of the taxonomic characters involved, the Rio Grande valley and associated lowlands provide a suitable pathway for north-south gene flow in central New Mexico (see discussion under "Zoogeography," p. 315).

Although Shannon and Lowe (1955) furnish ratios of parotoid gland size to body length, they do not limit these criteria to any certain age

group or sex. The validity of such ratios in terms of isometric growth of the parotoid gland and sexual dimorphism can be tested (fig. 7). It may be seen that juvenile specimens have a relatively larger gland and that gland width is more variable than length. No sexual dimorphism is apparent, but females are too few to demonstrate this adequately. In juveniles of less than approximately 30 mm. snout-vent, the cranial crests often are barely discernible, and the frontal area of the cranium undeveloped. These features and the parotoid gland, therefore, should be utilized to separate larger specimens only, preferably sexually mature adults (table 4).

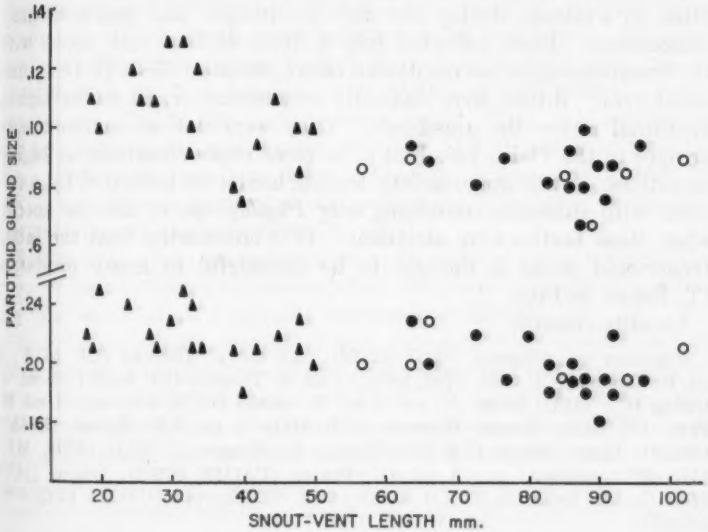

FIGURE 7.—Relationship of parotoid gland length/snout-vent length (lower symbols) and parotoid gland width/snout-vent length (upper symbols) to body size in *Bufo woodhousei* from the Zuni region.

● Sexually mature males ○ Sexually mature females ▲ Juveniles

The larvae of *B. woodhousei* have been collected throughout the summer months in slowly running streams, potholes, and cattle tanks. A sample of 12 taken at 7800 feet, July 3, 1959, are 7–12 ($\bar{x}$ 9.4) mm. body length; they have hindlimb buds. One day later, at 7100 feet, 12 larvae with well-developed legs and complete tails were collected; they measure 15–17 (15.7) mm. and approximate the size of transforming *B. woodhousei* from northern Arizona (Wright and Wright, 1949, p. 209). Six recently metamorphosed individuals, 13–19 ($\bar{x}$ 16.9) mm. snout-vent, were found on August 8, 1957, at 7000 feet.

That the Zuni toads have a biannual breeding regime is indicated by the formation of a chorus July 29, 1957, in a pond where large larvae were already present. Choruses often were heard after the initial summer rains, suggesting that perhaps summer and spring peaks of precipitation initiate breeding. Gravid females were found at two such choruses, but amplexed pairs were not seen. Thornton (1960, p. 181) found previously marked females of *B. woodhousei* in amplexus twice in the same breeding season at Austin, Texas. Bragg (1941, p. 112) stated that *B. woodhousei* breeds more or less independently of rain at Las Vegas, New Mexico.

Juveniles, previously characterized (Gehlbach, 1956, p. 365), were often in evidence during the day in riparian and oak-mahogany associations. Eight collected July 4, 1959, at 7100 feet, along with the transforming larvae mentioned above, measure 25–34 ($\bar{x}$ 31.2) mm. snout-vent. Adults were distinctly crepuscular or, on warm nights, nocturnal above the grasslands. They were not as common near arroyos in the Plains Life Belt as in more mesic situations at higher elevations. Their opportunistic feeding habits are indicated by specimens with stomachs containing only *Phyllophaga* or *Eleodes* species when these beetles were abundant. It is noteworthy that the latter tenebrionid genus is thought to be distasteful to many predators (T. Eisner, in litt.).

Locality records:

MCKINLEY CO.: Thoreau (MCZ 32813*); 5.5 mi. S. Thoreau (CU 6312); 6 mi. S. Thoreau (CU 5765, 5767, 6332); 7 mi. S. Thoreau (CU 6337); 16 mi. S. Gallup (CU 6313); 14 mi. N. and 7 mi. E. Gallup (UCM 6544–49); 4 mi. W. Page (CU 6334); Ramah Reservoir (CU 6311); 5 mi. SW. Ramah (UMMZ 123133); Upper Nutria (UMMZ 123134); Ft. Wingate (USNM 14395, MVZ 9342–48*); VALENCIA CO.: 8 mi. SE. Paxton (UMMZ 86604); Grants (MVZ 57640*); Mt. Sedgwick USNM 54363); 8 mi. SE. Thoreau (UMMZ 120298–99, 120307).

Hyla arenicolor Cope

The taxonomic status of canyon tree frogs from the Zunis is being studied elsewhere; certain observations on adult size and metachrosis, nevertheless, seem worthy of record here. Canyon tree frogs exhibit considerable color-pattern variation (Stebbins, 1951, p. 315). Zuni specimens were spotted usually with greenish or dusky, lichen-like markings, but when exposed to sunlight, they often became a uniform dirty cream or grayish white. The skin of such exposed individuals was noticeably more pustulose than in recently captured specimens found in dark crevices or cracks between rocks. The ground color of most *H. arenicolor* was yellow cream, tan, or light reddish brown, closely approximating the sandstone substrate on which they were resting.

Like *Bufo woodhousei*, this hylid may have two or more breeding seasons coinciding with separate peaks of precipitation. Heavy July rains initiated calling in pools where adult *H. arenicolor* had not been in evidence previously. Two adult females with large yolked eggs (ca. 1.6 mm. diameter) were collected July 6 and August 27, 1956; they measure 45 and 50 mm. snout-vent and are larger than most males taken with them (table 4).

Four transforming larvae, 17 to 20 mm. body length, were found July 2–6, 1956, at 7800 feet; eggs were laid July 16, 1956, in the same pond. On the latter date, in 1957, larvae in all stages including some with external gills were collected at 7800 feet. The water temperature was 75° F. at 11:20 a.m., the air 83° F., at this same locality on July 3, 1959, when a similar series was found. Of these specimens, 12 legless larvae measure 9–13 ($\bar{x}$ 10.9) mm. body length; 12 with both pairs of legs are 14–17 (15.7); and 12 recently transformed are 22–28 (24.7) mm. snout-vent. They are similar in size-group composition to a series (UMMZ 121950) obtained September 4, 1960, near Snowflake, Navajo County, Arizona, by Robert R. Miller, and they are larger than larvae from the Chiricahua Mountains, Cochise County, Arizona (Zweifel, 1961).

Adults and larvae were found often in rocky canyon pools of the riparian association at elevations where the pinyon-juniper or ponderosa pine associations dominated surrounding hillsides (pl. 1B). The tadpoles were usually associated with larvae of *Bufo woodhousei* and *Rana pipiens* in potholes 1–10 feet in diameter and not more than 10 inches deep. Such habitats were devoid of aquatic vegetation and probably resulted from recent stream subsidence. On July 18, 1956, five calling males were found in water-filled, eroded pits on the top of a sandstone outcrop at 6400 feet. This outcrop was isolated by level grassland, characterized by junipers and scattered pinyons at the east edge of the Grants malpais.

Locality records:

MCKINLEY CO.: 6 mi. S. Thoreau (UMMZ 120297); 7 mi. S. Thoreau (CU 6333); 8 mi. S. Thoreau (CU 6232, 6412); Ft. Wingate (USNM 14404, 53587); VALENCIA CO.: 1 mi. N. Cebolleta (UMMZ 86605); 4 mi. WSW. Cebolleta (UMMZ 86606); Ranger Station, Lobo Canyon, Mt. Taylor (UMMZ 86607); 11.5 mi. SSE. Grants (CU 6233); Grants (CU 5371, 5373, 5381, 5393, 5402; KUMNH 19360–7*).

***Pseudacris triseriata triseriata* Wied x *P. t. maculata* Agassiz**

Known from only seven published localities, the western chorus frog has been studied very little in New Mexico. Smith (1956) reassigned the subspecific name *maculata* to *P. nigrita* (=*P. triseriata*, Schwartz, 1957, p. 11) from Colorado, Utah, and northward. With the exception of a single specimen of *P. t. triseriata* x *P. t. maculata* from Colfax

County, New Mexico, he left the Arizona-New Mexico population as *P. t. triseriata*. His criterion was the greater tibia length/body length ratio in frogs from the latter states. Five specimens from the Zunis have ratios of 38.8–43.5 ($\bar{x}$ 40.9±0.4), thus placing them as *P. t. triseriata* x *P. t. maculata* intergrades (cf. Smith, 1956, table 2).

Recently transformed specimens, 13 and 14 mm. snout-vent, were collected July 13, 1949, in a meadow of the spruce-fir association at about 9200 feet. They were thought to be singing at the time of capture (Chenoweth, 1950, p. 532), but this seems improbable in view of their immaturity. Three males, also judged to be singing, were collected May 21, 1924, by Charles L. Camp at 7000 feet; they measure 29, 30, and 31 mm. snout-vent and are reproductively mature. All Zuni specimens have three distinct dorsal stripes that are broken posteriorly in the three adults.

Locality records:

MCKINLEY CO.: Ft. Wingate (MVZ 9339–41); VALENCIA CO.: Mark Elkin's Ranch, Mt. Taylor (CU 6338).

Rana pipiens Schreber

I have not attempted to assign Zuni leopard frogs to any particular geographic race in view of the notorious variability and inadequate definition of the various proposed subspecies (e.g., see Moore, 1944). In the study area these frogs may be many shades of green, brown, or gray; but they usually have 5–12 ($\bar{x}$ 9.1) large, regularly arranged dorsal spots and smooth skin. With respect to the latter feature, they are quite different from the highly pustulose leopard frogs occurring near Snowflake, Navajo County (UMMZ 121949), and 13 miles west of Chevalon, Coconino County (UMMZ 121951), Arizona, although from the same drainage system (Colorado River). The preserved specimens are small and may not represent the typical adult size range (table 4). A single female is 55 mm. snout-vent.

Lack of a large series and the few locality records reflect only the amount of attention directed toward collecting this species. My field notes indicate that *R. pipiens* is one of the most abundant anurans in the Zunis; it was seen commonly around isolated pools and streams in the riparian association of Roughlands and Montane Life Belts. Coues (1875, p. 631) found it to be similarly abundant along the Zuni River and Rio Gallo near Ft. Wingate. I did not see *R. pipiens* in cattle tanks or roadside ditches, nor did I note any breeding activity; however, larvae of all sizes were found throughout the summer months, and a great concentration of recently transformed individuals, 9–25 ($\bar{x}$ 21.6) mm. snout-vent (N1=5), was noted August 21–23, 1959, at 7200 feet.

Like *Bufo woodhousei*, leopard frogs also feed upon the tenebrionid beetle, *Eleodes*.

Locality records:

MCKINLEY CO.: 6 mi. S. Thoreau (CU 5773, 6306, 6340; CWGF); Thoreau (MCZ 32820–47,* 33300–05*); Ft. Wingate (USNM 16760); VALENCIA CO.: Grants (CU 5371–3).

Class Reptilia: Suborder Sauria

Crotaphytus collaris collaris Say x *C. c. baileyi* Stejneger

The western collared lizard, originally described as *C. baileyi* by Stejneger (1890, p. 103) from the Painted Desert, Little Colorado River, Arizona, can be characterized by its two discrete interorbital scale rows, a tan or brown head with darkly spotted green to blue throat (in males), and a sharply contrasting, spotted body pattern (Fitch and Tanner, 1951, pp. 549–550). Burt (1928) synonymized *baileyi* with nominate *C. collaris* and listed (Burt, 1933, p. 229) two localities in the Zuni region. Presently relegated to subspecific status, *C. c. baileyi* is the form usually found in the Zunis. This occurrence is not surprising because suitable habitats are more or less continuous between the type locality and the study area.

According to Fitch and Tanner (1951, p. 549) and Stebbins (1954, p. 310), a broad zone of intergradation exists between *C. c. collaris* and *C. c. baileyi*. This is evident in the Zunis, for 3 of 18 specimens have one scale common to both interorbital rows. On the basis of this criterion and the fact that certain Arizona specimens show a similar condition (Burt, 1928, p. 11), the three Zuni individuals may be labeled *C. c. collaris* x *C. c. baileyi*. It seems likely that a relatively smooth, east-west cline of variation is present in southwestern collared lizards (see discussion under "Zoogeography," p. 315).

Reasons for retaining subspecies in *C. collaris* and the description of a new intermontane Utah-Colorado race, *C. c. auriceps*, were given by Fitch and Tanner (1951). Although *C. c. auriceps* occurs in Montezuma County, Colorado (Maslin, 1959, p. 26), and logically in San Juan County, New Mexico, its characters could not be discerned in the Zuni sample or in specimens from Chaco Canyon National Monument, San Juan County (UMMZ 122892). This is somewhat puzzling when one considers that other reptiles with similar distributions are present in both areas, e.g., *Sceloporus undulatus elongatus*.

Fitch and Tanner (1951, fig. 1) show modal numbers of 14 for both supra- and infralabials of *C. c. baileyi*, 13 and 12 for these respective counts in *C. c. auriceps*. They apparently plotted labials on both left and right sides of the head in the same histogram. The figure is labeled "Numbers of Specimens" but does not agree with the number

of specimens examined (cf. Fitch and Tanner, 1951, p. 556); thus, the relatively small difference in labial number appears twice as strongly emphasized. Actually, such a distinguishing feature easily could be missed in possible intergrades.

Neither sexual dimorphism nor bilateral imbalance of labial scales was alluded to by the authors of *C. c. auriceps*. Etheridge (1960, p. 114) noted that males of *C. c. collaris* have larger heads and more robust lower jaws than females. In the Zunis, adult females are proportionately smaller than males (table 5) and possess fewer infralabials; seven have 11–14 ($\bar{x}$ 12.6), 12–16 (13.6) left and right infralabials respectively, and have 13–15 (14.0), 12–16 (14.3) left and right supralabials respectively. Eight males have 12–14 (13.1), 13–15 (13.8), 14–16 (14.5), and 13–16 (15.0) left and right infra- and supralabials. The bilateral imbalance is interesting in that the right side of the head seems to be favored, although this may not be meaningful in light of the sample size.

Collared lizards are a typical reptile of boulder-strewn hillsides where vegetation is sparse. Such situations usually are found on the lower slopes of mesas and canyons and at the malpais edge in the Zunis. On several occasions, foraging individuals encountered on the tops of mesas seemed to be attracted by large numbers of grasshoppers feeding on the thicker vegetation. These lizards are not restricted to the Roughlands Life Belt, but on the plains they are confined to the vicinity of rocky arroyos. *Sceloporus undulatus*, *Eumeces obsoletus*, *Masticophis taeniatus*, *Salvadora grahamiae*, and *C. collaris* were collected in and around an arroyo at 6400 feet in a cholla-juniper dominated section of the Plains-Roughlands continuum.

Females of *C. collaris* with the typical red breeding coloration were observed as late as August 11, 1959, but none collected in July or August held large eggs. Specimens taken by Emmet T. Hooper, May 7–9, 22, 1939, have only small ova. Two cross-banded hatchlings, 40 and 41 mm. snout-vent, with evident yolk-sac scars, were found August 25, 1951, at 6500 feet; thus, if about 51–74 days of incubation are needed (Fitch, 1956a, p. 234), egg-laying may occur in June or early July, ahead of the summer rains.

Locality records:

MCKINLEY CO.: Thoreau (MCZ 62420*); 5.5 mi. SE. Thoreau (CU 5748); 6 mi. S. Thoreau (CWGF); Ft. Wingate (USNM 16761); Gallup (USNM 27738); 14 mi. N. Gallup (UCM 6583–84); VALENCIA CO.: 1.5 mi. S. Grants (UMMZ 86616); 8 mi. SE. Grants (UMMZ 86615); 5 mi. E. Grants (CU 3051, 3376); 10.4 mi. S. Grants (CU 5747); 11.5 mi. SSE. Grants (UMMZ 122621–22); 7 mi. SE. Laguna (UMMZ 72649); 5 mi. NW. Rio Puerco (USNM 86937).

TABLE 5.—*Measurements in mm. and scale counts (range, mean, standard error) of some Zuni lizards*[1]

Species	N	Snout-vent length	Dorsal scales	Scales around midbody	Lamellae on right fourth toe
Crotaphytus collaris (♂)	8	90–105(97.9)	-	-	31–37(33.7±0.57)
" " (♀)	7	87–101(93.7)	-	-	
Sceloporus undulatus (♂)	25	40–63(51.8)	39–48(43.8±0.28)	42–50(46.1±0.25)	17–22(19.6±0.18)
" " (♀)	25	43–70(59.1)			
Sceloporus graciosus (♂)	6	47–55(50.5)	52–60(55.3±0.40)	50–59(53.9±0.52)	20–24(21.8±0.17)
" " (♀)	10	45–61(52.7)			
Urosaurus ornatus (♂)	16	39–52(48.3)	35–53(43.3±0.45)	-	21–26(23.3±0.26)
" " (♀)	13	42–53(47.5)			
Phrynosoma douglassi (♂)	10	56–83(69.9)	-	-	12–15(13.4±0.18)
" " (♀)	19	54–98(75.0)			
Eumeces multivirgatus (♂)	12	42–68(55.6)	57–61(59.4±0.23)	23–26(24.8±0.18)	10–16(12.8±0.35)
" " (♀)	11	49–70(65.5)			
Cnemidophorus velox (♀)	20	53–80(65.0)	168–190(177.2±1.4)	68–76(71.7±0.85)	29–34(31.1±0.48)

[1] Scale counts of both sexes are combined for each species.

***Holbrookia maculata campi* Schmidt**

Subspecific assignment of *H. maculata* in the Zuni region is based on specimens examined by Ralph W. Axtell (in litt.), who has revived the name *campi* and restricted it to Colorado Plateau populations (Axtell, 1958).

The lesser earless lizards that I collected are brown, red-brown, or gray dorsally, with 10–17 darker blotches or interconnected spots between extremes of limb insertions. They come from localities with soils of similar coloration. *H. m. campi* also approximates substrate color near Springerville, Apache County, Arizona, where specimens taken on soil-covered lava are dark brown or gray in general aspect. By contrast, an individual from the white sand along Choukai Wash, San Juan County, New Mexico (UMMZ 120277), is white to light gray, with darker gray dorsal spots (observations during three months in captivity). It is identical with *H. m. ruthveni*, the pallid "subspecies" of the White Sands, Otero County, New Mexico (see Smith, 1943b; 1946, pl. 20A). Other pallid specimens of *H. maculata* come from the vicinities of Montoya (Quay County), Pedernal (Torrance County), and Carrizozo (Lincoln County), New Mexico. I suggest that *H. m. ruthveni* be relegated to the synonymy of *H. m. approximans*, the form inhabiting lowlands south of the Colorado Plateau, since this white sand population is not geographically unique in its only distinguishing character, coloration.

In the Zunis, lesser earless lizards are inhabitants of the Plains Life Belt only. Four specimens come from the short-grass association in which snakeweed and rabbitbush is locally abundant. Another is from soil-covered malpais dominated by scattered junipers and apache plume. A third was in open grassland near a thicket of shadscale saltbush. Northeast of Prewitt where *H. m. campi* is associated marginally with *Cnemidophorus velox* and *Sceloporus graciosus*, a pursued earless lizard took refuge in the burrow of *Dipodomys ordi*. *C. velox* and *S. graciosus* frequent heavier cover such as saltbush or sage at this locality.

Gravid females with the following snout-vent length, date of collection, and egg number and size provide an estimate of local reproductive capacity in *H. m. campi:* 54 mm., May 12, 1939, 6 avg. 9.8 x 5.2 mm.; 57 mm., July 16, 1957, 3 avg. 13.4 x 7.4 mm.; 48 mm., July 16, 1957, 3 avg. 12.8 x 7.5 mm.; 48 mm., July 16, 1957, 2 avg. 13.8 x 7.6 mm.; 41 mm., July 5, 1959, 2 avg. 12.2 x 7.6 mm. It is possible that this iguanid deposits its eggs in response to summer rainfall (see discussion under *Sceloporus undulatus*).

Locality records:

MCKINLEY CO.: 5.5 mi. S. Thoreau (CU 5624); 4 mi. ENE. Prewitt (CU 5456); Upper Nutria (UMMZ 123135); VALENCIA CO.: Grants (MCZ 6824*); Point of

Malpais (UMMZ 86613); Acoma Pueblo (USNM 44696); Lava Beds (USNM 44697); 8 mi. SE. Thoreau (UMMZ 122889).

Comparative material examined:

H. m. campi.—NEW MEXICO: SAN JUAN CO.: 1 mi. N. Chaco Canyon Nat. Mon. (UMMZ 120277); ARIZONA: APACHE CO.: 7 mi. N. Springerville (UMMZ 121722). *H. m. approximans.*—NEW MEXICO: OTERO CO.: 3 mi. S. Alamagordo (UMMZ 64690, paratype of *H. m. ruthveni*); QUAY CO.: 3 mi. S. Montoya (UMMZ 69068–69); TORRANCE CO.: Pedernal (UMMZ 67850); LINCOLN CO.: Carrizozo (UMMZ 70080).

***Sceloporus undulatus tristichus* Cope x *S. u. elongatus* Stejneger**

Some attention has been given to the occurrence of *S. undulatus* in northwestern New Mexico. The possibility that the widespread form *S. u. tristichus* might intergrade with the northern subspecies, *S. u. elongatus*, was suggested by Burt (1933, p. 242). He considered *S. u. consobrinus* as the plateau lizard occurring in western McKinley County rather than *S. u. tristichus*, a name which he ascribed to intermediates between *S. u. elongatus* and *S. u. consobrinus*. Smith (1938, p. 16) defined *S. u. tristichus* in the sense employed here and outlined some intergrade populations in southern Utah and Colorado. He mapped *S. u. elongatus* as being present north of the Zunis but did not indicate specimens examined or published records from this part of the state. *S. u. elongatus* has been collected since at several localities in San Juan County, New Mexico, and Apache County, Arizona, the closest to the study area being Chaco Canyon National Monument (CU 5618) and Canyon de Chelly National Monument (UMMZ 120278).

The Zuni sample is clearly intermediate between *S. u. tristichus* and *S. u. elongatus* (table 6). An arithmetical measure of subspecific difference proposed by Ginsburg (1938) was revived to clarify this situation. With data drawn from Smith's study (1938, table 2), the following may be noted. For the best diagnostic character, i.e., number of dorsal scales from occiput to rump, the smallest overlap between *S. u. elongatus* and *S. u. tristichus* is 10.6 percent. This value is 18.1 percent when *S. u. elongatus* and the Zuni series are compared and 51.6 percent when *S. u. tristichus* and the Zuni material are compared. As regards the next best character, number of scales around midbody, overlap (intergradation) values are 23.0, 30.4, and 33.4 percent respectively. In both features Zuni specimens are nearer *S. u. tristichus*.

Plateau lizards from the vicinities of San Rafael, Paxton Springs, and El Morro National Monument, Valencia County, are most representative of *S. u. tristichus*, while those taken near Crownpoint, Prewitt, and Gallup, McKinley County, are closer to *S. u. elongatus*. Series collected around Thoreau, McKinley County, are intermediate

TABLE 6.—*Frequency distribution of scale counts in* Sceloporus undulatus tristichus, Sceloporus undulatus elongatus, *and the Zuni population of* S. undulatus[1]

	Dorsals																									
	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55					N	$\bar{x}$
S. u. tristichus	1	0	5	4	15	26	30	29	28	22	21	14														195	42.1
S. u. elongatus							7	5	7	5	11	28	37	34	41	32	23	29	6	3	3					251	48.1
Zuni population					1	1	3	7	14	8	15	7	5	2												63	44.1
	Scales around midbody																										
		36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	N	$\bar{x}$
S. u. tristichus		1	0	3	4	11	16	14	18	24	25	26	15	13	8	8	5	0	1							192	44.6
S. u. elongatus									4	10	5	24	22	29	27	28	20	10	17	7	8	1	0	3	1	216	49.3
Zuni population								1	2	6	11	12	8	10	4	1										55	46.1

[1] Data in part from Smith (1938).

in most respects. This northwest-southeast cline may be extended west through the Defiance Plateau, Apache County, Arizona, where I also have taken *S. u. tristichus* x *S. u. elongatus* (UMMZ 120280), to Grand Canyon National Park, Coconino County, Arizona (Williams, 1960, p. 26).

In view of this cline, one might question the retention of *S. u. tristichus* and *S. u. elongatus* as distinct subspecies. Other salient ecological-morphological differences in New Mexico populations, however, prevent me from lumping these races. With the exception of a few nearly unicolor specimens,[4] most *S. u. elongatus* from San Juan County, New Mexico, lack distinct dorsolateral and lateral light stripes and the spotted lateral pattern figured by Smith (1946, pl. 53 E, G) for *S. u. tristichus;* furthermore, adults are larger (45–83, $\bar{x}$ 64 mm. snout-vent, 25 San Juan County specimens) and possesses more fourth-toe lamellae (22–25, $\bar{x}$ 23.3$\pm$0.29) than *S. u. tristichus* x *S. u. elongatus* (cf. table 5). They are decidedly more scansorial, frequenting large boulders and cliff situations in contrast to marked terrestrial propensities in typical individuals of *S. u. tristichus* and the Zuni population.

Although *Sceloporus undulatus* was the most ubiquitous reptile studied, it did not enjoy the wide elevational range of *Phrynosoma douglassi* or *Thamnophis elegans* (fig. 3). The species was most abundant in Roughlands associations, especially the pinyon-juniper. While found to a limited extent at the upper edge of the Plains-Roughlands continuum, *S. undulatus* usually was outnumbered by *S. graciosus*, *Crotaphytus collaris*, and *Cnemidophorus velox* in this habitat. Specimens were conspicuously absent from cliffs inhabited by *Urosaurus ornatus*. They were uncommon on large boulders and the lower trunks of trees. Most individuals utilized elevated sites such as fallen tree trunks for sunning purposes and as apparent vantage points but were distinctly terrestrial in foraging habits. Body temperatures of 10 individuals foraging at 7400 feet were 29–37, ($\bar{x}$ 33.1$\pm$0.98)° C.

Evidence presented by Anderson (1960, p. 66), Martin (1958, p. 57), and others indicates that reproductive activity in certain reptiles is correlated with the beginning of summer rains. Similar observations on *S. undulatus* have prompted the following remarks. Plateau lizards carrying well-developed eggs have been found as early as June 13, 1957. Most females over 40 mm. snout-vent held eggs when collected before mid-July, but none taken in August contained eggs.

[4] A polychromatic variant occurs, usually uniform dark brown or gray but occasionally with slightly darker or lighter lateral stripes (e.g., see Legler, 1960, p. 181; Smith, 1946, p. 217). It has been found in the Guadalupe Mountains, New Mexico (UMMZ 121745), but not in the Zuni region.

It is possible that the onset of July rainfall provides these lizards and *S. graciosus*, *Urosaurus ornatus*, and *Holbrookia maculata* with optimum conditions for oviposition. Ten eggs of *S. undulatus*, averaging 12.5 x 8.5 mm., were recovered from a one-inch depression beneath a small sandstone slab July 23, 1956 at 7300 feet. The substrate was damp, loose sand, and the eggs were not buried.

Large eggs taken from females often contained embryos with well-developed eyes as did all eggs from the clutch obtained July 23, 1956. Similar predepositional embryonic growth was reported for *S. undulatus* in Arizona and *S. orcutti* (Stebbins, 1954, pp. 240–244). This might be expected if fertilized eggs are retained for an extended length of time as suggested here. The phenomenon may be adaptive in a semiarid region like the Zunis; i.e., to insure annual reproduction within the limits of optimum activity temperatures, postdepositional development thus can be completed in a relatively short time when oviposition is keyed to adequate summer moisture conditions. Hatchlings, 23–28 mm. snout-vent, have been collected as early as July 26, August 9, and August 12 in different summers.

Locality records:

MCKINLEY CO.: 5.5 mi. S. Thoreau (CU 5623); 6 mi. S. Thoreau (CU 5088-9 5448, 5622, 5681, 5697; UMMZ 121919, 122885–7); between Thoreau and Continental Divide (UMMZ 120311); Gallup (CU 5843); 14 mi. N. Gallup (UCM 6630–37); Ft. Wingate (USNM 14406–7, 8250, 8491, 9548; UCM 6638); Manuelito (USNM 87031); 5 mi. SE. Baca (UIMHN 39685–6*); 4 mi. NNE. Prewitt (UMMZ 120284); 11 mi. W. Ramah (UMMZ 122884); VALENCIA CO.: Cubero (USNM 87032–4); El Morro Nat. Mon. (KUMNH 15121–6*; UMMZ 122794); 2 mi. W. El Morro Nat. Mon. (CU 5606); 2.5 mi. E. Laguna Pueblo (KUMNH 28065*); 8 mi. SE. Thoreau (UMMZ 122890); Shuman's Ranch (UMMZ 86608); 15 mi. E. Grants (KUMNH 15294–5*); 10.4 mi. S. Grants (CU 5608); 1.5 mi. S. Grants (UMMZ 86609); 4 mi. WSW. Grants (UMMZ 86610); 18 mi. SW. Grants (UMMZ 86611); 17 mi. SW. Grants (UMMZ 86612).

Comparative material examined:

S. u. elongatus.—NEW MEXICO: SAN JUAN CO.: Chaco Canyon Nat. Mon. (CU 5618; UMMZ 122896); 7 mi. E. Blanco (UCM 7337–47); 43 mi. SSE. Bloomfield (UCM 7350–55); 2 mi. S. Colo.-N. M. state line on U.S. Rt. 666 (UCM 13294–13301); ARIZONA: APACHE CO.: 10 mi. W. Window Rock (UMMZ 120280, intergrades with *S. u. tristichus*); Canyon de Chelly Nat. Mon. (UMMZ 120278, 120281). *S. u. consobrinus*.—NEW MEXICO: EDDY CO.: 2 mi. NW. Carlsbad Caverns Nat. Park, headquarters area (UMMZ 121745).

Sceloporus graciosus graciosus Baird and Girard

Sagebrush lizards, represented by the nominate subspecies, usually are considered to be widespread in northwestern New Mexico (Smith, 1946, p. 495; Stebbins, 1954, p. 317). Published records, however, are available only for Rio Arriba (Cope, 1900, p. 389; VanDenburgh, 1924, p. 205) and Sandoval (Maslin and others, 1958, p. 335) counties.

To these may now be added several localities in San Juan and McKinley counties (see below). It seems doubtful that *S. g. graciosus* is common south of the Colorado Plateau; specimens have yet to be found in Valencia County. Small, disjunct populations inhabit the sand dunes of Chaves County, New Mexico, and Ward and Winkler counties, Texas (Sabath, 1960).

Many herpetologists have followed VanDenburgh (1922, p. 262) in separating the three subspecies of *S. graciosus* as follows: *S. g. graciosus* has 42–53 ($\bar{x}$ 47.8) dorsal scales from occiput to rump, *S. g. gracilis* has 52–68 (60.8), and *S. g. vandenburghianus* has 48–66 (54.8). It is significant that the dorsal scale count is high in Zuni material (table 5). The same is true of San Juan County specimens, for 16 from the vicinity of Blanco (CU 5617, UCM 7274–79) have 51–58 ($\bar{x}$ 54.3$\pm$0.57) dorsals and 10 taken south of Bloomfield (UCM 7280–87, 7348–49) have 51–58 (54.9$\pm$0.86). Zuni and San Juan County series approximate *S. g. vandenburghianus* in number of dorsal scales, but the males resemble *S. g. graciosus* with their widely separated, bright-blue belly patches and distinctly striped dorsum.

The specimens at hand represent variation that remains to be studied thoroughly. The entire polytypic complex is in need of revision as further evidenced by specimens from northern Arizona (Durham, 1956, p. 222) with equally high dorsal scale counts and by "nominate *graciosus*" from northeastern Utah (Legler, 1960, p. 180) with confluent belly patches. It is possible that Colorado Plateau specimens are subspecifically distinct from those of the Great Basin; hence, the present racial allocation is tentative.

Since a pallid, arenicolous form of *S. graciosus* is known from southeastern New Mexico and adjacent Texas, it is of interest to report similar variation in northwestern New Mexico. Specimens collected on white sand along Choukai Wash, San Juan County (UMMZ 120283), approximate the description of *S. g. graciosus* provided by Sabath (1960). The dark-brown dorsal stripes seen in Zuni specimens are lacking or are indicated only faintly. These sagebrush lizards are light beige but retain the four white dorsal stripes. Two males have very light belly patches and throat mottling; the latter feature is apparently absent in southeastern New Mexico (Sabath, 1960).

The terrestrial nature of *S. g. graciosus* is well documented (Eaton, 1935, p. 12; Woodbury and Woodbury, 1945) and is particularly evident in the Zunis, where this lizard was observed in open, relatively level situations marked by the saltbush-sage association or pure stands of big sagebrush and loose clay or moderately sandy soil. In only one instance was *S. g. graciosus* abundantly associated with *S. undulatus*. At the base of the Vermilion Cliffs north of Prewitt, it was at least five times more common than its congener

in patches of spiny saltbush in the Plains-Roughlands ecotone. *Cnemidophorus velox* also was present but uncommon.

Females, 54 and 55 mm. snout-vent, collected June 10, 1957, each contained four eggs averaging 12.0 x 7.5 and 13.5 x 8.0 mm. respectively. Three others, 50, 52, and 57 mm., held, respectively, three (avg. 12.9 x 6.0), four (avg. 12.3 x 7.2), and four (avg. 12.0 x 6.0) eggs on July 9. Eight females taken July 23, 1959, had deposited their annual egg clutches, possibly in response to the onset of summer rainfall. No hatchlings were ever observed.

Locality records:

MCKINLEY CO.: 3 mi. N. Thoreau (CU 5699); 3 mi. NE. Thoreau (CWGF); 4 mi. NNE. Prewitt (CU 5452, 5600, 5698; UMMZ 120282); Lizard Canyon, Satan Pass (ANSP 20987*); 14 mi. N. Gallup (UCM 6608–11); 5 mi. S. Manuelito (UMMZ 122888).

Comparative material examined:

Sceloporus g. graciosus.—NEW MEXICO: SAN JUAN CO.: 1 mi. N. Chaco Canyon Nat. Mon. (UMMZ 120283); Chaco Canyon Nat. Mon. (UMMZ 122902); Blanco Trading Post (CU 5617); 7 mi. E. Blanco (UCM 7274–79); 34–43 mi. SSE. Bloomfield (UCM 7280–87, 7348–49); 2 mi. S. Colo.-N. M. state line on U. S. Rt. 666 (UCM 13292); 0.5 mi. S. Colo.-N. M. state line on U. S. Rt. 17 (UCM 1303–4).

***Uta stansburiana stansburiana* Baird and Girard x *U. s. stejnegeri* Schmidt**

This is apparently another species with a north-south pattern of subspecific intergradation in the Zuni region; however, the present allocation must remain tentative until a series can be secured and the races of *U. stansburiana* are better characterized. Zuni specimens have 88 and 100 dorsal scales between the interparietal plate and posterior edge of the thighs. One has contiguous prefrontals; the other has the prefrontals separated by two small scales (see Smith, 1946, p. 277).

Based on present subspecific concepts in *U. stansburiana*, this intergrade zone extends north into San Juan County, New Mexico. Five specimens from Chaco Canyon National Monument (CU 5619; UMMZ 122909) have 94–106 ($\bar{x}$ 99.2$\pm$1.5) dorsals; 6 from seven miles east of Blanco (UCM 7392–97) have 106–112 (108.7$\pm$0.67), and 10 taken two miles south of the New Mexico-Colorado state line (UCM 13377–86) have 100–114 (107.4$\pm$2.0). The large number of dorsals and prefrontal contact in only one San Juan County specimen indicate that influence from *U. s. stejnegeri* is relatively slight.

The apparent rarity of *Uta* in the Zunis is difficult to explain. The two precise localities, at 6900 and 7100 feet, are relatively open grassland with sandy soil, rabbitbush, snakeweed, and scattered one-seed junipers. The localities lie at the northwestern edge of mixed gras-

land that extends along the Rio San Jose from the Rio Grande valley (see Castetter, 1956, fig.). This ground uta is more abundant in eastern Valencia county at lower elevations and is common in the San Juan Basin to the north.

Locality records:

MCKINLEY CO.: Thoreau (CWGF); 4 mi. ENE. Prewitt (CU, specimen lost); VALENCIA CO.: (KUMNH 12192*).

***Urosaurus ornatus linearis* Baird x *U. o. wrighti* Schmidt**

Urosaurus has been the subject of considerable taxonomic debate. This genus was lumped with *Uta* by Schmidt (1953), Stebbins (1954), and Oliver (1943) subsequent to separation of the two genera by Mittleman (1942). Other authors such as Smith (1946), Smith and Taylor (1950a), and Stejneger and Barbour (1943) followed Mittleman. Although reasons for dividing *Uta* (in the sense of Mittleman, 1942) are equivocal as demonstrated by Savage (1958), arguments for this split advanced by the latter author appear well founded. I consider *Urosaurus* as the proper generic name for forms occurring in the Zuni region and specifically allied with *Uta ornata* Baird and Girard (1852).

The problem of discerning geographic variation in *Urosaurus ornatus* seems to result from Mittleman's failure (1942) to use significant quantitative methods in defining the various forms. This was demonstrated by Oliver (1943), whose method of treating *U. ornatus* was followed with modification by Langebartel and Smith (1954, pp. 130–133). Murray (1953) questioned the use of degree of dorsal scale carination as a taxonomic character and, in addition to Duellman (1955, p. 8) and Gehlbach (1956, pp. 367–368), reported the failure of color to characterize subspecies in *U. ornatus*. Williams (1960, pp. 27–28), experiencing difficulty with Mittleman's diagnoses, followed Langebartel and Smith (1954, pp. 130–133) in lumping *U. o. linearis* under *U. o. schotti* but recognized *U. o. wrighti*.[5]

Mittleman (1942, pp. 138, 146) recorded *U. o. wrighti* from McKinley and San Juan counties, New Mexico, and *U. o. linearis* from "generally south of Lat. 35° [in New Mexico] except for the southeastern quarter of the state." Within the Zuni region, *U. ornatus* exhibits variability that, at first glance, suggests intergradation between *U. o. linearis* and *U. o. wrighti* (Gehlbach, 1956, p. 368); however, examination of series of supposedly typical individuals reveals that most characters currently in use do not adequately separate these subspecies. Clinal variation is present in at least one important char-

[5] I provisionally consider *linearis* as a separate subspecies in view of the distinctiveness of specimens from south-central Arizona (fig. 8). A thorough examination of variation in *U. ornatus* from the Arizona-Mexico border region would clarify this situation but that is beyond the scope of my discussion.

acter (fig. 8). Since *U. ornatus* is greatly in need of a modern systematic revision, I hold subspecific allocation of Zuni specimens tentative at this time.

Using Oliver's methods (1943, pp. 100–101), the following may be noted in *U. ornatus* from the Zunis. Enlarged dorsal scales are present in two distinct rows on each side of the smaller vertebrals in 28 percent of a series of 29 specimens; they are in two rows with additional enlarged dorsals tending to form a third outer row in 66 percent and in three quasi-distinct rows in 6 percent. Carination of these scales varies from a flat, weak keel to a sharp raised point with all types of intermediate forms observable. Similarly, complete gradation in the merging of dorsal tail-base scales with adjacent scutes is present. Thirty-one percent of the specimens have the enlarged dorsals separated by two rows of small vertebral scales, while 69 percent possess only one row of vertebrals.

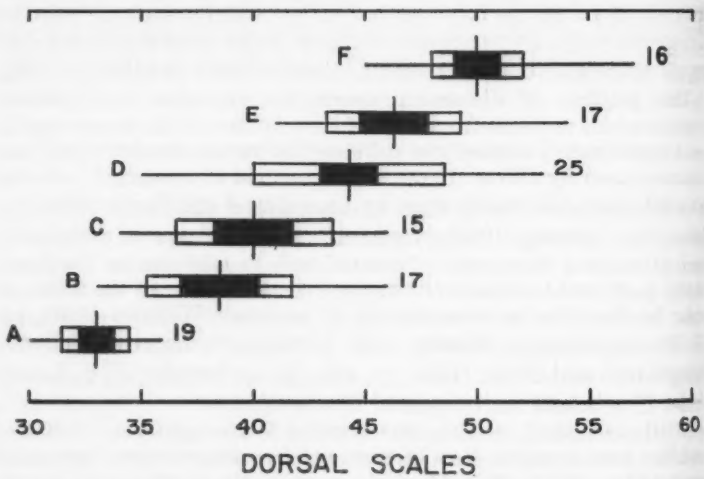

FIGURE 8.—Variation in the number of enlarged dorsal scales of *Urosaurus ornatus* from Arizona, New Mexico, and Utah. (Horizontal line=range; vertical line=mean; solid bar=two standard errors of the mean; hollow bar=one standard deviation. Sample size to right of range; provenance of sample to left: A, Pima and Santa Cruz Counties, Arizona; B, Cochise Co., Arizona; C, Yavapai Co., Arizona; D, McKinley and Valencia Counties, New Mexico; E, Kane Co., Utah; F, San Juan Co., Utah.)

Thirteen individuals from the northeast of the Zuni Mountains have 40–53 ($\bar{x}$ 44.5$\pm$0.96) enlarged dorsals from the anterior insertion of the forelimbs to anterior insertions of hindlimbs; 16 from the southwest side have 35–47 (42.3$\pm$0.95). If these counts are compared with those of *U. ornatus* from Utah and Arizona, a north-south

cline may be visualized (fig. 8). This gradient of increasing scale size extends into Sonora, Mexico (cf. Oliver, 1943, fig. 1). Two rows of enlarged dorsals on each side of the vertebrals are present in about 80 percent of *U. ornatus* from southern Arizona. In approximately 90 percent of those from northern Arizona and Utah, there is a partial or complete third, outer row.

The rock uta is abundant on mesa edges and cliffs in the Roughlands and lower Montane Life Belts. Its local distribution is determined apparently by the availability of large boulders or by areas of broken, exposed rock; hence, elevational limits are imposed only by the lack of such habitat. Each mesa partially isolated by level grassland is inhabited by a distinctive population marked by close resemblance to local rock color. While these utas usually were observed in a vertical position, they were found rarely in standing trees and shrubs. Characterization of *Urosaurus* as a plant-dwelling genus (see Lowe, 1955b) does not hold for *U. ornatus* in the Zunis. This is well illustrated by its occurrence in montane canyon-head situations and absence from ridgetops. Arboreal vegetation is present in both places, but large rocks or outcrops are not prevalent in the latter.

Data on reproduction indicates that the oviposition of *U. ornatus* may coincide with adequate summer moisture conditions. Gravid females with the following snout-vent length, date of collection (1959), and egg number and size provide circumstantial evidence: 54 mm., June 13, 5 avg. 6.7 mm. diameter; 47 mm., July 14, 3 avg. 12.8 x 7.0 mm.; 45 mm., July 16, 4 avg. 10.6 x 5.9 mm.; 48 mm., July 16, 2 avg. 12.2 x 6.1 mm. Specimens taken July 23, 1959, had laid their eggs as had *Sceloporus graciosus* and *S. undulatus* at the same locality. Hatchlings, 25 and 26 mm. snout-vent, were found on August 10; three more, 24, 25, and 27 mm., were collected on August 25, the following summer.

Locality records:

MCKINLEY CO.: 5.5 mi. SE Thoreau (CU 5625); 6 mi. S. Thoreau (CU 5129; UMMZ 120292); 7 mi. S. Thoreau (CU 5610, 5628); 8 mi. S. Thoreau (CU 5449); 5 mi. NE. Thoreau (CU 5686); between Thoreau and Continental Divide (UMMZ 120310); 4 mi. NNE. Prewitt (CU 5451, 5599; UMMZ 120203); 14 mi. N. Gallup (UCM 6092–93); VALENCIA CO.: 8 mi. SE. Grants (UMMZ 86614); 17 mi. SW. Grants (CU 5127, 5695); 25 mi. S. Grants (MCZ 62308*); 2.5 mi. E. Laguna Pueblo (CU 5678); El Morro Nat. Mon. (CU 5605); 2 mi. W. El Morro Nat. Mon. (CU 5445).

Comparative Material Examined:

U. o. linearis.—ARIZONA: COCHISE CO.: Carr Canyon, Huachuca Mts. (CU 3539); 5 mi. SE. Sunnyside (CU 5126); Cave Creek Canyon, Chiricahua Mts. (CU 2469, 5122); YAVAPAI CO.: 1 mi. N. Yarnell (CU 3036, 3513). *U. o. schotti*.—ARIZONA: PIMA CO.: Arivaca (CU 1789); 5 mi. NE. Arivaca (CU 2461); SANTA

CRUZ CO.: 3.5 mi. E. Patagonia (CU 5504); 9 mi. E. Sonoita (CU 877-8); Trench Mine Station (CU 5514). *U. o. wrighti.*—UTAH: KANE CO.: near Kanab (UMMZ 73380–84); SAN JUAN CO.: near Moab (UMMZ 68573–78).

***Phrynosoma douglassi hernandesi* Girard**

The Zuni Mountains are the type locality of *Tapaya ornatissima* Girard (1858) by restriction (Reeve, 1952, p. 928). Presently known as *Phrynosoma douglassi ornatissimum*, this lizard and the closely related *P. d. hernandesi* have been reviewed most recently by Reeve (1952), who based the above locality restriction on Stejneger's designation (1890, p. 113) of neotypes of *P. d. ornatissimum*. Critical examination of 29 adult (table 5) and 17 subadult topotypes and the neotypes reveals that the Zuni population is composed actually of individuals with the characters of both *P. d. ornatissimum* and *P. d. hernandesi* (as defined by Girard, 1858, pp. 395–396; Reeve, 1952, pp. 924–928).

With regard for diagnostic features, the adult specimens have: (1) temporal spines shorter than their basal diameter in 65 percent and about equal to basal diameter in 35 percent; (2) head width at jaw angle exceeding temporal width in 6 percent, about equal to temporal width in 44 percent, and less than equal in 50 percent; (3) dorsal dark spots light bordered mesially in 45 percent; and not light bordered in 55 percent. Only the first character favors allocation with *P. d. ornatissimum;* numbers two and three are more typical of *P. d. hernandesi*. These adults might be considered intergrades, but the added characterization of subadults and all specimens with special regard for locality data demonstrates that the above features vary ontogenetically as well as environmentally.

Seventeen subadults, 24–45 mm. snout-vent, resemble *P. d. hernandesi* in color pattern as do five larger adults from the Montane Life Belt. Vivid dorsal coloration is virtually absent in these specimens; their dorsal blotches lack light mesial borders. In contrast, adults from Roughlands and Plains localities are bright orange or reddish brown in general aspect (brighter ventrally) and possess mesially and posteriorly light bordered blotches as in *P. d. ornatissimum*. Tail length/snout-vent length is 0.369–0.471 ($\bar{x}$ 0.429) in subadults, 0.429–0.542 (0.470) in adults; hence, absolute tail length is unacceptable for comparative purposes as proposed by Reeve (1952, pp. 924, 928) unless ontogenetic variation is accounted for. Furthermore, it appears that adults have relatively broader heads and longer temporal spines than subadults. None of the latter have the jaw angle width greater than the temporal width or have temporal spines equaling their basal diameter in length.

The idea that environmental gradients produce both *P. d. hernandesi* and *P. d. ornatissimum* in a single geographic area is not new.

Cope (1900, p. 417), concerned with *P. d. ornatissimum*, stated: "According to Stejneger this is the desert form of the species. In Arizona Dr. Merriam only found it on the Painted Desert, while he found the *P. d. hernandesi* in the cedar and pine belts in the San Francisco Mountain region." Bailey (1913) included both races in his New Mexico, Upper Sonoran Life Zone, but only *P. d. hernandesi* in the Transition Zone. Eaton (1935, p. 16) commented on his inability to distinguish *P. d. ornatissimum* from *P. d. hernandesi* in northern Arizona, and Durham (1956, p. 222) described specimens of both "subspecies" from the Grand Canyon. Bragg and Dundee (1949, p. 57) and Lowe (1947) observed color variation correlated with ecological differences near Las Vegas and Socorro, New Mexico, respectively. In view of past and current difficulties in separating the two forms, I suggest that *P. d. ornatissimum* be placed in the synonomy of *P. d. hernandesi*, which has page priority (see Girard, 1858, pp. 395–396).

Short-horned lizards are certainly the most eurytopic reptiles of the Zuni region if not of New Mexico. They could be observed readily in all major vegetational associations except the spruce-fir but were most abundant in the pinyon-juniper savanna. Specimens were taken in the alpine-tundra association at 11,300 feet on Mt. Taylor (La Mosca Lookout), a greater elevation than attained by any other species studied (fig. 3). This is possibly the highest occurrence of any reptile or amphibian in the Southwest.

The birth of ten young (24–26, $\bar{x}$ 24.8 mm. snout-vent) was observed in a clump of rabbitbush at 6400 feet, 11:00 a.m., August 14, 1957. All were extruded within ten minutes and, with freedom from their investing membrane, immediately buried themselves in the loose, sandy soil. They were medium gray with only the dark-brown dorsal spots of the salient color pattern. Other dates (1957) of parturition and accompanying brood size are June 25 (15), July 11 (8), July 20 (6), August 3 (21), August 10 (11) for females taken between 7000 and 7500 feet and maintained in outdoor cages at 7200 feet. A single juvenile, 20 mm. snout-vent, was collected on August 12 at 8200 feet. Specimens with ova, 0.6–1.5 mm. in diameter, were found throughout the summer months; one from 11,300 feet contained 11 eggs averaging 4.2 mm. on July 17, 1956.

Locality records:

MCKINLEY CO.: 6 mi. S. Thoreau (CU 5119, 5233, 5447, 5632, 5703, 5709; UMMZ 120409); Ft. Wingate (USNM 14396, 14408); Prewitt (KUMNH 28063*); Rio Puerco, Continental Divide (AMNH 62853–4); Seven Lakes (CU 5620); Gallup (CU 5841); 10 mi. N. Gallup (TNHC 11654–5); VALENCIA CO.: Grants (MCZ 6791*; USNM 44805); 10.4 mi. S. Grants (CU 5601); La Mosca Lookout, Mt. Taylor (CU 5453); Mark Elkin's Ranch, Mt. Taylor (KUMNH 28062*);

Shuman's Ranch (UMMZ 86617); El Morro Nat. Mon. (KUMNH 11298-9*); Ojo Redondo (CU 5707); Mt. Sedgwick (USNM 44566); McCartey's (USNM 16000-1); Lava Beds (USNM 44702).

***Cnemidophorus velox* Springer**

Lowe and Zweifel (1952, p. 229) have characterized appropriately the systematics of whiptail lizards: "Perhaps there is no genus of lizard occurring in North America today that has been studied and continues to be studied with as much uncertainty and confusion as *Cnemidophorus*." In keeping with this statement, *C. velox* was, for many years, an unrecognized species. Probably it was reported in New Mexico by Yarrow (1875, p. 558) as *C. octolineatus* and by Hallowell (1854, p. 145), Cope (1900, p. 603), and VanDenburgh (1924, p. 213) as *C. gularis*. Burt (1931, p. 124) included it under *C. sexlineatus perplexus* and listed Zuni specimens from Grants and Gallup. Lowe (1955a) reviewed the nomenclatorial history of this Colorado Plateau species that Burger (1950a, p. 4) and others had confused with *C. exsanguis*, formerly known as *C. sacki* (Duellman and Zweifel, 1962). Maslin and others (1958, p. 342) reported *C. velox* from San Juan, Taos, Rio Arriba, and San Miguel Counties, New Mexico. Duellman and Zweifel (1962, fig. 10) utilized my distributional data on this species in their review of the "*sexlineatus*" group of *Cnemidophorus*.

C. velox may be separated from *C. exsanguis* primarily on the basis of size and color pattern (pl. 3; table 7). Adults of the former are never spotted conspicuously, have more widely separated paravertebral light stripes and predominantly blue or blue-gray tails in contrast to the spotted brown to greenish (distally) tailed adults of *C. exsanguis*. The two species are similar in scutellation (table 7). They are sympatric presumably in northern Arizona (Lowe, 1955a, p. 3), but this relationship is not certain in the Zunis. On two occasions a large seemingly spotted whiptail was seen foraging with typical adults of *C. velox* near Thoreau. Neither individual was collected, and other differences were not noted. Since some large *C. velox* develop light areas at the anterior ends of adjoining scales in the lateral dark stripes, these observations cannot be cited as indicating sympatry in the Zunis.

Among the striped whiptails of New Mexico west of the Rio Grande, the scale counts of *C. velox* are closest to those of *C. exsanguis* and furthest from *C. perplexus* and *C. inornatus;* such features adequately separate *C. velox* from *C. burti*, a much larger spotted species (table 7). Unlike *C. velox*, *C. perplexus* is spotted as an adult and often has a wavy middorsal light stripe. *C. velox* and *C. inornatus* are the only unspotted species in western New Mexico. Both have blue tails, but *C. inornatus* is not larger than 67 mm. snout-vent, typically has a

bluish venter, and rarely (4 out of 37 New Mexico specimens) lacks the middorsal light stripe. In *C. velox* the venter is usually white, although occasionally tinged with blue, and the middorsal stripe is more often incomplete or absent (table 8). The condition of this stripe apparently remains constant during ontogeny (pl. 3A).

TABLE 7.—*Comparison of range and mean of meristic characters of striped whiptails (Genus* Cnemidophorus*) present in western New Mexico*[1]

Species	Dorsal scales around midbody	Scales between paravertebral stripes	Femoral pores	Maximum snout-vent length mm.	Spots
C. burti	98–115(104.7)	5–11(8.0)	32–44(38.3)	130	yes
C. exsanguis	62–86(74.8)	2–8(4.6)	30–44(36.8)	101	yes
C. inornatus	55–78(62.0)	7–11(8.6)	33–39(35.0)	67	no
C. perplexus	71–80(74.9)	9–13(10.2)	34–40(37.3)	86	yes
C. velox	67–80(72.5)	5–10(7.9)	28–38(32.9)	84	no

[1] Data in part from Duellman and Zweifel (1962).

There is relatively little geographic variation in *C. velox* (table 8). It is perhaps significant that populations from the immediate vicinity of the San Juan Basin are somewhat more uniform in structure and closer to the species mode than those to the south and west. Specimens from Catron County, New Mexico, have the fewest dorsal scales [6] and are smallest in size, closely approaching *C. inornatus* in these characters. Specimens from Kane County, Utah, have the largest number of dorsals and, including Navajo County, Arizona, and San Juan County, Utah, femoral pores. The four samples most peripheral to the San Juan Basin, those from the Zunis, Catron, Apache, and Kane Counties, show the greatest separation of paravertebral light stripes and incidence of a complete middorsal stripe.

Maslin (1959, p. 44) identified two specimens (UMMZ 76881) as syntypes of *C. velox* although he added that they were reidentified as *C. stictogrammus* by Richard G. Zweifel. Zweifel (in litt.) said that he had no notes on these specimens; he later examined and tentatively determined them as *C. sexlineatus*. I concur with this identification. Clearly the specimens in question are not syntypes of *C. velox*. Even their locality data, Lee's Ferry, Coconino County, Arizona, differs from that given by Springer (1928, p. 103) for the four original syntypes: "Three were taken at Oraibi, Arizona, and one at Pueblo Bonito, New Mexico." Some mixup is indicated since *C. sexlineatus* reaches its westernmost limits in San Miguel County, New Mexico, and cannot be expected at Lee's Ferry.

[6] I agree with Zweifel (1959, p. 66) that the number of dorsal scales around midbody is a more accurate count than the number from occiput to rump. This may be seen in the degree of variation in the Zuni population (table 5).

TABLE 8.—*Range, mean, and standard error (latter of dorsal scales and femoral pores only) in* Cnemidophorus velox

Locality	N	Snout-vent length	Dorsal scales around midbody	Femoral pores	Scales between paravertebral stripes	Middorsal stripe complete
Apache Co., Ariz.	5	48–69(62.2)	69–75(71.2±1.1)	30–36(31.8±2.4)	8–10(9.2)	0
Navajo Co., Ariz.	5	55–71(61.6)	72–75(73.8±0.4)	33–35(34.2±0.3)	6–8 (7.0)	80%
Catron Co., N.M.	8	49–68(58.4)	67–75(69.5±0.9)	30–35(32.6±1.6)	6–9 (8.1)	75%
Rio Arriba Co., N.M.	15	53–73(63.6)	71–76(73.2±0.56)	30–36(32.7±1.9)	6–9 (7.2)	33%
San Juan Co., N.M.	15	37–79(60.9)	68–76(72.6±2.6)	28–37(32.4±2.3)	6–9 (6.9)	7%
Zuni region, N.M.	20	53–80(65.0)	68–76(71.7±0.85)	30–36(31.8±1.8)	6–10(8.1)	60%
Kane Co., Utah	15	57–80(68.9)	74–80(76.7±0.65)	31–35(33.5±1.1)	8–10(9.1)	61%
San Juan Co., Utah	7	52–84(72.0)	68–75(71.4±0.75)	31–38(34.4±2.2)	5–10(7.6)	43%
Total sample	90	37–84(64.1)	67–80(72.5±1.6)	28–38(32.9±0.4)	5–10(7.9)	45%

Of the 90 specimens of *C. velox* examined during this study, none were males. Comparative dissections revealed only famales of *C. exsanguis* and *C. tessellatus*, but bisexual samples of *C. inornatus* and *C. tigris* were noted. This problem is complicated further by the existence of two kinds of nonspotted whiptails in the Zuni region. One is typical of *C. velox* as previously characterized and has, in addition, abruptly enlarged scales preceding the gular fold. The other is represented by two males (UCM 6579–80) from 14 miles north of Gallup that resemble *C. inornatus* in having the bright-blue venter and smaller scales in front of the gular fold. These specimens, with 68 and 75 dorsal scales around midbody, could be the males of *C. velox*, or they might represent *C. inornatus* in sympatry with *C. velox*; indeed, when more specimens become available and this perplexing situation is studied further, present species concepts involving *C. velox* and *C. inornatus* may be altered radically.

In the Zunis, Colorado Plateau whiptails were most common in open areas of the Roughlands Life Belt especially where the saltbush-sage association occurred in isolated patches in the pinyon-juniper savanna. They were associated occasionally with *Sceloporus undulatus* in these habitats and with *Sceloporus graciosus* where scattered spiny saltbush and one-seed junipers dominated a sandy area at the lower edge of the Roughlands near Prewitt. Although seldom found above the Roughlands-Montane continuum, they sometimes occurred in ponderosa pine stands in open, logged-off spots or along dry creek beds to approximately 7800 feet.

Gravid females with the following snout-vent length, date (1939) of collection, and egg number and size give some estimate of local reproductive capacity in this whiptail: 77 mm., May 28, 3 avg. 6.5 x 15.2 mm.; 80 mm., June 13, 4 avg. 11.2 x 16.0 mm.; 73 mm., June 22, 4 avg. 8.2 x 15.2 mm. A specimen collected June 30, 1956, had an enlarged oviduct but only small eggs measuring 0.5–1.5 mm. in diameter. None of the individuals taken in July held enlarged eggs; hence, *C. velox* apparently does not oviposit coincidentally with summer rainfall. A hatchling, 34 mm. snout-vent, was collected August 13; another, 37 mm., on August 20, 1957.

Locality records:

MCKINLEY CO.: 4 mi. S. Thoreau (CU 5450); 5.5 mi. SE. Thoreau (CU 5614); 6 mi. S. Thoreau (CU 5675; UMMZ 120410, 120289); 7 mi. S. Thoreau (CU 5626); 4 mi. NNE. Prewitt (UMMZ 120286); between Thoreau and Continental Divide (UMMZ 120309); Ft. Wingate (USNM 16762–63, 80357); 16 mi. S. Gallup (CU 5609); 10 mi. W. Gallup (MVZ 65805); 14 mi. N. Gallup (UCM 6578–80); Gallup (UMMZ 120287); Crownpoint (UNMCV 1162); VALENCIA CO.: 8 mi. SE. Paxton (UMMZ 86619); 1 mi. N. Cebolleta (UMMZ 86620); 4 mi. W. McCartey's (UMMZ 86618); 11.5 mi. SSE. Grants (CU 5458).

Comparative material examined:

C. velox.—ARIZONA: APACHE CO.: Little Colorado River (UMMZ 85054); NAVAJO CO.: 1 mi. N. Winslow (UMMZ 74025); NEW MEXICO: CATRON CO.: 3 mi. NE. Horse Springs (UCM 6095–6102); RIO ARRIBA CO.: 7 mi. N. El Rito (UMMZ 69081); SAN JUAN CO.: 7 mi. E. Blanco (UCM 7250–59); 43 mi. SE. Bloomfield (UCM 7260–62); 1 mi. N. Chaco Canyon Nat. Mon. (UMMZ 120288); Chaco Canyon Nat. Mon. (UMMZ 122915); UTAH: KANE CO.: 6–7 mi. NW. Kanab (UMMZ 73323–24); SAN JUAN CO.: 3 mi. W. Monticello (UMMZ 121484-85); Natural Bridges Nat. Mon. (UMMZ 120285).

Eumeces multivirgatus multivirgatus Hallowell x *E. m. epipleurotus* Cope

The taxonomic status of southwestern members of the *E. multivirgatus* complex recently has been discussed by Lowe (1955c), Maslin (1957), Mecham (1957), Heyl and Smith (1957), and Tanner (1957). These authors are in essential agreement that *E. gaigeae* (=*E. m. epipleurotus;* see Axtell, 1961) and *E. taylori* are pattern variations of *E. multivirgatus*, but their opinions diverge as to the proper allocation of the three available names. Mecham (1957, pp. 113–116) proved that *E. taylori* is simply an allelomorphic pattern variant of *E. multivirgatus;* thus, there is no reason, in the interest of biosystematics, for retaining *E. m. taylori* as a nongeographic subspecies as Lowe (1955c) and Tanner (1957 p. 116) do. Maslin (1957, p. 87) and Mecham (1957, p. 112) suggested that *E. gaigeae* represents a stage in the ontogenetic pattern change of *E. multivirgatus*. Such loss of color pattern is well documented in the *E. fasciatus* group but has not been demonstrated effectively in the many-lined skinks.

A series of 25 adults and 5 juveniles of *E. m. multivirgatus* from the Zuni region corroborates previous suggestions concerning the derivation of the color pattern of *E. m. epipleurotus*. Complete pattern reduction can be observed in this variable sample and is comparable to Tanner's diagrams B through D (1957, fig. 1). An adult female, collected August 12, 1960, lost the mid-dorsal light stripe in 21 months of captivity.

To test possible correlation of pattern change with increasing size, and presumably age, the hybrid index method of Sibley (1950, p. 112) and others was adapted for present use. The characters examined were middorsal light line, dorsal dark line on the first and/or second scale rows, lateral light line on the sixth and/or seventh scale rows, and tail color pattern. The degree of intensity of each stripe was graded per specimen on a scale of 0 (=present, as in typical *E. m. multivirgatus*) to 3 (=absent, as in typical *E. m. epipleurotus*). Tail color-pattern change (from blue to blue gray with lines, to brown with lines, and ultimately to brown with lines and spots) was graded in like manner. By adding the character values for a specimen, a

total of 0 indicated *E. m. multivirgatus*, 12 denoted *E. m. epipleurotus*, and 1–11 indicated ascending degrees of intermediacy. The specimen totals plotted against snout-vent length show ontogenetic change of color pattern from *E. m. multivirgatus* to *E. m. epipleurotus* with increasing size irrespective of sex (fig. 9).

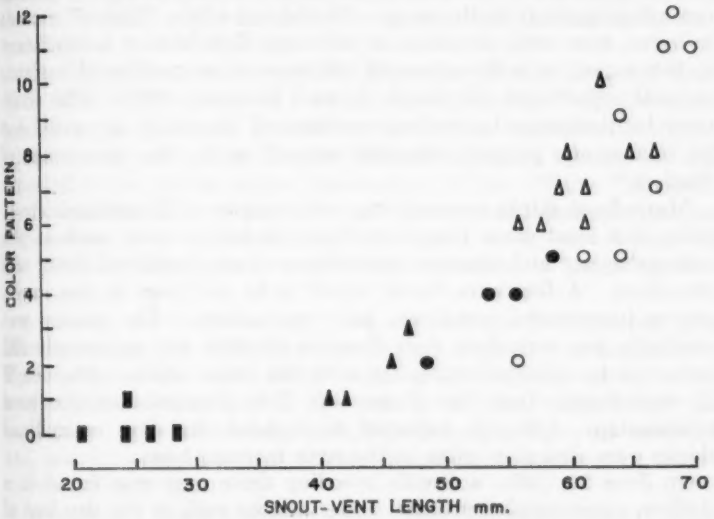

FIGURE 9.—Relationship of color-pattern to snout-vent length in *Eumeces multivirgatus* from the Zuni region. (The color-pattern of nominate *multivirgatus* is 0, that of *epipleurotus* is 12.)

▲ Males
● Females
■ Hatchlings
} With blue tails

△ Males
○ Females
} Without blue tails

Suggested bases for retaining *E. m. epipleurotus* as a southern race of *E. multivirgatus* are: (1) ontogenetic pattern reduction (not present in nominate subspecies; Maslin, 1957; Mecham, 1957); (2) distinctive juvenile pattern (see Maslin, 1957, fig. 1E); (3) posterior border of last supralabial confluent with posterior border of last infralabial (supralabial projecting caudad at least 15 percent of its length in nominate subspecies; Maslin, 1957, p. 89). The first and second criteria apply to the Zuni skinks; however, for the third, only 38 percent of the adults possess the labial feature of *E. m. epipleurotus* on both sides of the head and 25 percent resemble *E. m. multivirgatus*, with the remainder being asymmetrical. While this third criterion remains to be tested in other New Mexico populations, some influence from the northern race is expected if physiographic and ecologic

factors operating in this situation are similar to those effecting north-south intergradation in other Zuni reptiles.

Polychromatism in *E. multivirgatus* presents an interesting possibility for increased adaptation. It would be of distinct advantage for this skink, a wide-ranging form, to possess a variety of phenotypes each of which is superior in adaptive value to others in a given habitat occurring regularly in the range. Prevalence of the "*taylori*" variant in lower, more xeric situations in southern New Mexico is significant in this regard as is the apparent difference in proportion of variants in local populations (Gehlbach, in ms.; Mecham, 1957). The tendency for darkening in southern portions of the range is carried out by ontogenetic pattern reduction as well as by the occurrence of "*taylori*."

Many-lined skinks occurred in a wide variety of Roughlands situations, but most often they were taken in heavy cover such as the oak-mahogany and riparian associations where broad-leaf litter was abundant. A few were found under rocks and logs in the dryer, pinyon-juniper and ponderosa pine associations. The species was decidedly less saxicolous than *Eumeces obsoletus* and apparently did not occur in ecological sympatry with this larger skink. Absence of *E. multivirgatus* from the Plains Life Belt demonstrates this local relationship. Although collected throughout the day, many-lined skinks were seen more often in the early morning hours.

On June 28, 1954, a female brooding three eggs was found in a shallow, cup-shaped depression under a loose rock in the dry bed of Cottonwood Creek at 7200 feet. The soil was damp only around the eggs, which measured 14.0 x 9.5, 14.5 x 8.5, and 15.0 x 7.8 mm. Five eggs averaging 14.2 x 8.6 mm. were dug from a Pueblo Indian ruin at a depth of approximately five inches on August 7, 1957. These were accompanied by a many-lined skink that escaped capture in the maze of rocks and loose, moist soil. Another female of the "*epipleurotus*" type and four recent hatchlings, 22 to 27 mm. snout-vent, were taken together on August 17. These hatchlings and one other, 29 mm., collected July 29, have the sharply contrasting juvenile pattern of *E. m. epipleurotus*.

Locality records:

MCKINLEY CO.: 6 mi. S. Thoreau (CU 5435, 5596, 5615, 5693; UMMZ 123529); 8 mi. S. Thoreau (CU 5145); Ft. Wingate (USNM 16015–17); 10 mi. N. Ramah (UMMZ 122883); VALENCIA CO.: 8 mi. SE. Thoreau (UMMZ 120408); 8 mi. NE. Grants (CU 5436); 17 mi. SW. Grants (CU 5607); 1.5 mi. S. Lookout Mt. (CU 5691); 3 mi. SW. Page (CU 5692); 2 mi. W. El Morro Nat. Mon. (CWGF).

***Emueces obsoletus* Baird and Girard**

Burt (1929) and Taylor (1935, pp. 205–220) have reviewed geographic variation in this species. Adult specimens collected in the

Zunis fit their descriptions of New Mexico and Arizona material; however, two hatchlings differ slightly from published accounts of juvenile coloration. They are 35 and 36 mm. snout-vent, with a glossy-black ground color that is equally as intense on the venter as on the dorsum. White spots on the head are confined to the upper labials, outside edges of the parietals, prefrontals, and supranasals, the six to eight scales immediately craniad and caudad of the ear, and the first four infralabials.

The Great Plains skink apparently reaches the northwestern limit of its New Mexico range in Valencia County and probably does not occur on the Colorado Plateau further to the north. Locally it inhabits rocky situations in the Plains-Roughlands continuum and especially the cholla-juniper association of the Plains Life Belt. It was collected among rock outcrops in arroyos and along the malpais edge where there was relatively little shrub cover. In contrast to the plains-dwelling iguanid, *Holbrookia maculata*, it seems to shun open areas.

A female, accompanied by three recently hatched young, was discovered July 18, 1956, near the malpais edge on scoriaceous lava. Upon pursuit, she took refuge under a lava chunk, which, when overturned, revealed her in the process of consuming one of the hatchlings. The other two hatchlings subsequently were collected and are the ones described above; the adult escaped.

Locality records:

VALENCIA CO.: Grants (USNM 44806); 1.5 mi. S. Grants (UMMZ 86621); 11.5 mi. SSE. Grants (CU 5455); 8 mi. SE. Paxton (UMMZ 86623); 4 mi. W. McCartey's (UMMZ 86622).

Suborder Serpentes

Thamnophis dorsalis dorsalis Baird and Girard

I follow Fitch and Milstead (1961) in replacing *Thamnophis cyrtopsis* Kennicott with the older Baird and Girard name. This arrangement is not entirely convincing because the black-necked gartersnakes, *T. dorsalis*, *T. eques*, and *T. marcianus*, of the Southwest and Mexico have been confused widely (see Wright and Wright, 1957, p. 770); Fitch and Milstead (1961) admit that the original description of *T. dorsalis* is not sufficiently diagnostic to identify the missing type with certainty.

The single male of *T. d. dorsalis*, collected during the present study, was found while I was investigating a breeding aggregation of *Scaphiopus hammondi* and *Bufo punctatus* on the eastern edge of the Grants malpais at 6400 feet (Gehlbach, 1956, p. 369). This locality is at least 10 miles from the nearest stream of appreciable size, the Rio San Jose. The specimen has 174 ventral scales, 76 subcaudals, and 19–19–17 dorsal scale rows. It is unlike most *T. d. dorsalis* in that it

shows no dorsal spotting caudad of the neck region and has a very low subcaudal count (see Milstead, 1953). Reduction of posteriodorsal dark spots has been observed in specimens from Farmington, San Juan County (UMMZ 66973–4), and Pinos Altos, Grant County (UMMZ 75626), New Mexico, but this reduction was not of the magnitude seen in the Zuni snake.

T. dorsalis is not as abundant as *T. elegans* in northwestern New Mexico. It does not occur frequently in the pinyon-juniper association and, therefore, is separated somewhat ecologically from *T. elegans*. In addition to the Farmington specimens, others from the Acoma Indian Reservation (UNMCV, specimen lost), Suwanee, Valencia County (UNMCV 44, 117), Aztec (AMNH 5298), and junction of the Los Pinos and San Juan rivers, San Juan County (A. Harris, in litt.), were taken below 6000 feet. Milstead's record (1953, p. 372) from ten miles north of El Rita [sic], Rio Arriba County, is questionable; I consider the specimens (UMMZ 84330) to be juveniles of *T. elegans*.

Locality records:

VALENCIA CO., 11.5 mi. SSE. Grants (CU 5053).

Thamnophis elegans vagrans Baird and Girard

Of all snakes represented in the Zuni region by a single geographic race, *T. elegans* exhibits the greatest morphological variation and widest range both geographically and altitudinally (fig. 3). Variation is especially apparent in the number of ventral and subcaudal scutes of both sexes (table 9). The means of these features approximate those given by Fitch (1940, figs. 3, 4), but the ranges are greater than his combined Arizona-New Mexico sample. Six specimens have 23 anterior scale rows and one has divided preoculars, traits which Fitch (1940) considered rare in *T. e. vagrans*.

Color pattern is subject to extremes of manifestation in the Zuni population. Certain individuals are nearly uniform olive brown dorsally with only a trace of the middorsal light stripe and dark dorsal spots. Others are marked with brilliant lemon-yellow stripes and clear black spots. In these the dark postparietal crescentic marks are strikingly similar to those of *T. dorsalis* and may have been part of the reason for misidentification in other studies. Black spots along the belly midline are present in varying degrees. Although a great variety of colors and patterns can be observed, no specimen possesses the ash-gray ground color seen by me in *T. e. vagrans* in southern Utah; all are some shade of brown.

Juveniles usually are spotted distinctly, with the dorsal and lateral light stripes reduced in intensity and the black nuchal crescents clearly indicated. To my eye, juveniles are colored more cryptically than adults, which are generally less spotted. There is apparently

TABLE 9.—*Scale counts and color pattern measurements (range, mean, standard error) of some Zuni snakes*[1]

Species	N	Ventrals	Subcaudals	Dorsals-midbody	Body blotches	Tail blotches
Diadophis punctatus (♂)	2	211, 214	72	17(4)	–	–
" " (♀)	2	230, 231	69(2)			
Pituophis melanoleucus (♂)	7	229–240(233.6±2.1)	57–72(65.8±2.5)	29–31(30.3±0.39)	44–63(51.2±2.4)	13–18(14.6±0.28)
" " (♀)	2	230, 234	53, 62			13, 14
Thamnophis elegans (♂)	19	161–176(166.3±1.1)	78–96(86.8±1.1)	19–21(20.9±0.14)	–	–
" " (♀)	12	159–171(163.7±1.0)	71–90(75.5±1.6)			
Crotalus atrox (♂)	3	185, 192	22, 24, 25	25–26(25.3±0.24)	35–40(37.0±0.76)	6, 5(2)
" " (♀)	4	184, 187, 189	19(2), 20(2)			3(2), 4(2)
Crotalus viridis (♂)	13	171–178(174.6±0.65)	23–28(24.9±0.47)	23–27(25.2±0.22)	34–44(39.1±0.65)	6–10(8.5±0.11)
" " (♀)	10	172–180(174.9±1.0)	19–22(20.4±0.27)			5–8(7.0±0.10)

[1] Dorsal scale row and body blotch counts of both sexes are combined for each species.

some ontogenetic change in the color pattern of this subspecies, but the variety of polychromatism renders its interpretation especially difficult.

Twenty young born on August 26, 1957, to a female, 1051 mm. in total length, are 142–160 ($\bar{x}$ 152) mm. snout-vent, 49–58 (55) mm. tail length. It is noteworthy that the above female is the largest *T. e. vagrans* on record; her brood averages considerably larger than those reported by Wright and Wright (1957, p. 799). Other dates of birth and brood size are July 11 (13) and July 2 (15) for females measuring 744 and 979 mm. total length, respectively. All brood records are from specimens captured at 7200 feet in the riparian association bordered by oak-mahogany and pinyon-juniper associations. The adults were maintained in outside cages at the same elevation.

As indicated by Coues (1875, pp. 614–615) in observations made along the Zuni River, the wandering garter snake is typically semiaquatic in the Zunis. Specimens of all sizes were encountered frequently in riparian situations where the amount of exposure varied according to elevation. The form was most abundant in Montane and Roughlands Life Belts, but a few individuals were found on the plains in or near arroyos stemming from the uplands. Of 23 specimens with food in their stomachs, 17 had eaten *Rana pipiens*, both adults and larvae; 6 contained *Sceloporus undulatus* and *Bufo woodhousei*; 2 held *Peromyscus* species; 1 held *Perognathus flavus*; and 1 each had eaten *Phrynosoma douglassi* and *Ambystoma tigrinum*. On several occasions, this garter snake was seen chasing anuran larvae under water.

Locality records:

MCKINLEY CO.: Thoreau (MCZ 62258–64, 62454–70*); 6 mi. S. Thoreau (CU 5054, 5444, 5586, 5616, 5668); Ft. Wingate (USNM 16764–5, 14397–14401); 15 mi. N. Gallup (MVZ 63704*); 5 mi. SW. Ramah (UMMZ 123132); VALENCIA CO.: 1.5 mi. SW. San Mateo (UMMZ 86626–7); 4 mi. W. McCartey's (UMMZ 86628); 4 mi. WSW. Cebolleta (UMMZ 86624–25); Paguate (UMMZ 86629); Canyon Lobo Ranger Station, Mt. Taylor (UMMZ 86630); 7 mi. W. San Fidel (AMNH 74501, 74786, 75966); El Morro Nat. Mon. (KUMNH 8557*); 7.8 mi. SE. Grants (UMMZ 123131).

Diadophis punctatus regalis Baird and Girard

Confusion in applying the name *regalis* has resulted apparently from a scarcity of museum specimens. Blanchard (1942, pp. 56, 62) considered *D. regalis regalis* as distinct from *D. regalis laetus* by absence or great reduction of the neck ring. Only two New Mexico specimens were available to him, however. Wright and Wright (1957, p. 161) followed Blanchard, although Schmidt and Smith (1944, pp. 89–90) previously had regarded presence or absence of the neck ring as anomalous and size and ventral scale counts as more

significant. These latter authors synonymized *D. r. laetus* with *D. r. regalis* but named *D. regalis blanchardi*. They were followed by Stebbins (1954, p. 489), who further suggested, as had Garman (1883, p. 73), that perhaps all ringneck snakes constitute a single species.

Another rearrangement was fostered by Smith and Taylor (1945, p. 48), who maintained Blanchard's views on *D. regalis* and *D. r. laetus* in "view of the paucity of data on these snakes" but synonymized *D. r. blanchardi* with nominate *D. regalis*. Brown (1950, p. 145) supported their position. The form *D. dugesi* had been linked subspecifically with *D. regalis* (Taylor and Smith, 1938, p. 240) and *D. punctatus* (Villada, 1878) but was considered as a distinct species by Blanchard (1942, pp. 51–54). Utilizing new material from western Texas and southeastern New Mexico, Mecham (1956) combined *D. regalis* with *D. punctatus* but left subspecific boundaries in question.

Taxonomic appraisal of Zuni ringneck snakes and others from New Mexico necessitated the following brief review of variation in southwestern and Mexican *Diadophis*. I have been fortunate in seeing more material than was available to previous workers. Series from single localities, nevertheless, are nonexistant; hence, certain morphologically similar specimens were grouped politically (Arizona, Utah, Chihuahua). Further evidence for considering the montane forms *D. regalis* and *D. dugesi* as subspecies of *D. punctatus* has been found. The racial boundaries left open by Mecham (1956) can now be approximated, and *D. r. laetus*, along with *D. r. blanchardi*, may be placed in the synonymy of *D. p. regalis*.

As suggested by Cope (1900, pp. 544–545), the neck ring is a polychromatic character with dominance in some areas and variable manifestation in others. It occurs in some individuals from Sandoval County (New Mexico), Yavapai County (Arizona), and Chihuahua (Mexico), but is absent in others. Zuni specimens have neck rings (pl. 4) as do those from Catron, Sierra, and Grant Counties in southwestern New Mexico. Material examined from central and southeastern New Mexico usually lacks the ring, but one individual from Eddy County has it interrupted middorsally (Mecham, 1956). Incomplete neck rings also occur in the prairie race, *D. p. arnyi* (=*D. p. docilis*, Mecham, 1956), and specimens from Utah, Trans-Pecos, Texas (Blanchard, 1942, pp. 63, 73; Mecham, 1956), and Jalisco, Mexico (UIMNH 47866). Most specimens from Utah and Trans-Pecos, Texas, lack the ring, whereas most Arizona and Mexican individuals have it well developed.

Similarly, extent of the yellow color of the venter on the dorsal scale rows varies from a single spot on a few anterior scales of the first

row to nearly complete coverage of the first or first and second rows; for example, one of the three Zuni specimens has yellow limited to a spot on each scale of the first dorsal row, while the others have the first row nearly covered with, and the second row spotted with, yellow (pl. 4). Most Arizona and New Mexico ringnecks show the former condition; most Utah snakes, the latter. In *D. p. dugesi* the yellow pigment is confined usually to the ventrals, but specimens from Hidalgo (UIMNH 17635), Jalisco (AMNH 3711–12), and Nayarit (AMNH 19724) resemble anteriorly those from Arizona-New Mexico. An individual from Durango, Mexico, (ISM, uncataloged) has faint yellow spots on the first dorsal row and thus appears to be intermediate between *D. p. dugesi* and *D. p. regalis*. A similar specimen from Chihuahua (BYU 14243) has yellow confined to the venter caudad of the neck region.

The Guadalupe Mountains population (Eddy Co., N. M.-Culberson Co., Tex.) also exhibits intermediacy in coloration as well as certain meristic features described below. One specimen from Walnut Canyon (CCNP 2197) has yellow spots on all scales of the first dorsal row, thus resembling most Arizona-New Mexico ringnecks. Another (CCNP 2201) has such spots only on the anterior quarter of the body, while a third has a uniformly gray dorsum. The McKittrick Canyon snakes have no yellow pigment dorsally except in the region of the partial neck ring, where it reaches approximately the fifth scale row on each side. Restriction of yellow pigmentation to the ventral scales is supposedly typical of *D. p. arnyi* (Stebbins, 1954, pp. 360, 489) as well as *D. p. dugesi* (Blanchard, 1942, p. 51).

In southwestern and Mexican *Diadophis*, the number of labial scales (usually 7/8), loreals (1–1), and pre- and postoculars (2–2) is geographically stable, although often asymmetrical. By contrast, body length and three of four other meristic characters vary clinally (table 10). Two steps in the temporal and dorsal scale row clines are important because they fall at major breaks in the range of nonclinal ventral scale variation (fig. 10). One of these steps occurs in the Guadalupe Mountains south through the Sierra Vieja and Chisos Mountains, Trans-Pecos, Texas, between the ranges of *D. p. arnyi* in west Texas and *D. p. regalis* in central New Mexico. The other lies between the ranges of *D. p. regalis* in Chihuahua, Mexico, and *D. p. dugesi* in southern Mexico. The steps are indicated by changes in frequency involving 15–15 and 17–17 dorsal scale rows and 1–1 temporals.

That certain meristic characters exhibit clines in different directions is evident. Ringneck snakes from the Sierra Vieja-Chisos region are closest to *D. p. arnyi* in dorsal and temporal counts but resemble *D. p. regalis* in number of ventrals. Almost the opposite situation exists

TABLE 10.—*Variation of* Diadophis punctatus *in the Southwest and Mexico*[1] (Dorsal scale counts are from midbody and anal regions; unusual deviations are omitted as are asymmetrical temporal counts. Range and mean are given for subcaudal scale counts and body length. Provenance and size of samples: A = west Texas other than Trans-Pecos (21); B = Guadalupe Mountains, Eddy County, N.M., and Culberson Co., Texas (10); C = Sierra Vieja and Chisos Mountains region, Trans-Pecos, Texas (12); D = central and western New Mexico (16); E = Arizona (22); F = Utah (16); G = Chihuahua, Mexico (8); H = Mexico south of Durango (22))

Counts	A	B	C	D	E	F	G	H
Subcaudals (♂)	49–58(52.0)	47–61(51.4)	53–67(60.2)	69–72(71.0)	63–74(70.7)	72–81(75,7)	62–71(65.6)	52–61(56.2)
" (♀)	41–57(49.0)	39–47(43.2)	54–59(55.7)	60–69(64.0)	62–68(64.5)	64–73(67.8)	55–67(59.7)	45–56(52.1)
Dorsal scales	15–15(55%)	15–15(50%)	15–15(60%)	15–15(1%)	17–17(35%)	17–17(5%)	17–17(20%)	17–17(53%)
	17–15(27%)	17–15(38%)	17–15(40%)	17–15(87%)	17–15(55%)	17–15(90%)	17–15(80%)	17–15(32%)
Temporal scales	1–2(rare)	1–2(29%)	1–2(10%)	1–2(47%)	1–2(60%)	1–2(44%)	1–2(40%)	1–2(43%)
	1–1(usual)	1–1(71%)	1–1(90%)	1–1(33%)	1–1(10%)	1–1(31%)	1–1(40%)	1–1(10%)
Body length (mm.)	98–422	147–358(255)	222–445(372)	162–545(374)	325–645(434)	167–602(381)	239–510(381)	143–433(297)

[1] Data in part from Blanchard (1942), Fouquette and Lindsey (1955), Jameson and Flury (1949), Mecham (1956), Minton (1959), Schmidt and Smith (1944), Smith (1943a), and Tanner (1941).

in the Guadalupes, where most specimens approximate *D. p. arnyi* in dorsal and ventral counts and *D. p. regalis* in frequency of temporal combinations; however, a male from Walnut Canyon is closest to *D. p. regalis* in having 206 ventrals. On the basis of clinal variation and intermediate coloration, ringneck snakes from the Guadalupe

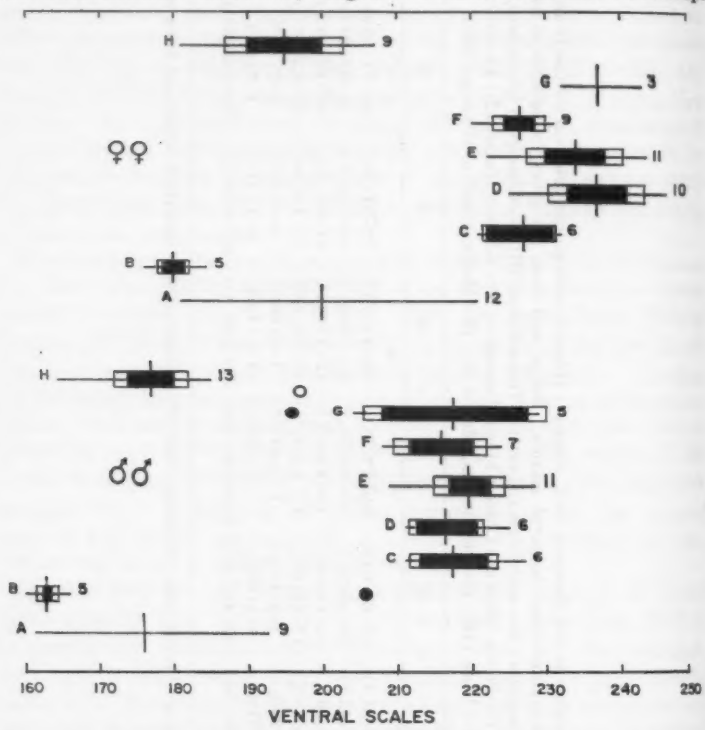

FIGURE 10.—Variation in the number of ventral scales of *Diadophis punctatus* from the Southwest and Mexico. (Solid circles=intergrades; hollow circle=a specimen from Durango. See table 10 for other provenance data and figure 8 for explanation of diagram.)

Mountains south through Trans-Pecos, Texas, are considered intergrades between *D. p. arnyi* and *D. p. regalis*. Perhaps this zone of intergradation extends further north. Bragg and Dundee (1949) reported *D. p. arnyi* seven miles south of Las Vegas, San Miguel County, New Mexico; typical *D. p. regalis* occurs 65 miles to the west in Sandoval County.

West of the Guadalupe Mountains, ventral scale counts are uniformly high among specimens from central and western New Mexico, Arizona, Utah, and northern Chihuahua (fig. 10). Zuni ringnecks

are thus allocated with *D. p. regalis*, which is best distinguished by the large, sexually dimorphic number of ventrals. Thirty-three females have 220–247 ($\bar{x}$ 233.9±1.3) ventrals, while 28 males have 204–229 (217.3±1.2). Over a range of 43 ventrals there is only a nine-scale overlap between the sexes. On the other hand, 25 males have more subcaudals (62–81, $\bar{x}$ 70.9±0.98) than 28 females (55–73, 64.8±0.73). Here the overlap, 11 scales in a range of 26, is relatively greater, rendering number of subcaudals inferior to number of ventrals as an external criterion of sex. Equally striking sexual dimorphism obtains in *D. p. arnyi* and *D. p. dugesi*, which have fewer ventrals than *D. p. regalis* (fig. 10).

A single ringneck from southern Chihuahua (BYU 14243) has only 196 ventrals, suggesting intergradation with *D. p. dugesi* (Tanner and Robison, 1960, p. 68). It further resembles *D. p. dugesi* in number of dorsal scale rows (17–17) and the coloration described above. A specimen from Durango is likewise intermediate in ventral count and color (see above and fig. 10) but is closest to *D. p. regalis* from Chihuahua in number of dorsals (17–15) and temporals (1–1). Unfortunately, the other Durango specimen (UMMZ 102527) is in such poor condition that exact analysis of its scutellation is impossible. The Durango ringnecks and the above-mentioned individual from Chihuahua are considered intergrades since they bridge the previous morphologic and geographic gap between *D. p. regalis* in Chihuahua and *D. p. dugesi* in Nayarit.

Martin and Harrell (1957, p. 469) listed *D. punctatus* among vertebrates that may have dispersed between the eastern United States and Mexico. The relationship of *D. p. dugesi* to *D. p. arnyi* through intergradation with *D. p. regalis* implies that dispersal via the Sierra Madre Occidental and the montane Southwest deserves equal consideration. Lower ventral and subcandal scale counts in *D. p. dugesi* and *D. p. arnyi* could be considered convergence in view of the distributional hiatus in northeastern Mexico. This hiatus may not be real, however, because a specimen described by Blanchard (1942, p. 59) from San Luis Potosi, Mexico, appears to be somewhat intermediate between *D. p. arnyi* and *D. p. regalis* and indicates that other such individuals occur in the region and possibly to the north also. Blanchard (1942, pp. 129–132) described breaks in range, considered by him important in maintaining *D. p. regalis* and *D. p. dugesi* as distinct species, that recently have been filled in.

The secretive nature of *Diadophis* can be cited as a reason for its seeming rarity in the Southwest and Mexico. In the Zunis, a male collected August 17, 1959, was crawling over sandstone rubble near a small stream at 9:45 a.m. Although the locality, in pinyon-juniper-ponderosa ecotone at 7200 feet, had been worked intensely

in preceding summers, ringneck snakes previously had not been found there. Another individual found in the riparian association displayed typical tail-curling behavior as did the above specimen (pl. 4). A female found September 13, 1958, at 6400 feet in an area of broken lava and sandstone contains 18 eggs, the largest being 2.5 mm. in diameter. It is 650 mm. in total length and has three divided ventrals, including the first one anterior to the divided anal plate.

Three live specimens from Cottonwood Gulch (6 mi. S. Thoreau) suggests that some color change may occur during the growth of *D. p. regalis*. The smallest, 268 mm. total length, collected June 29, 1961, has a yolk-sac scar and is slate gray above with a bright-yellow belly and the characteristic red subcaudal surface. Another, 377 mm., is similar to the juvenile ventrally but has a greenish-gray dorsum. The largest specimen, 478 mm. with a stub tail, has an orange-yellow belly that shades into coral red in the region of the vent and is also greenish gray dorsally. Its individual dorsal scales are mottled with black and have a black spot at the anterior end (pl. 4). In each of these three ringnecks, the belly is moderately to heavily spotted with black as in all other southwestern and Mexican specimens.

Locality records:

MCKINLEY CO.: 6 mi. S. Thoreau (UMMZ 120276, 122627, 122947); VALENCIA CO.: 6 mi. E. Grants (UNMCV 158).

Comparative material examined:

D. p. regalis.—NEW MEXICO: BERNALILLO CO.: SW¼, Sec. 22, T9N, R4E (UNMCV 412); Jaral Canyon, Sandia Mts. (UNMCV 36); CATRON CO.: 3 mi. N. Glenwood (BYU 13976); DONA ANA CO.: Mesilla Valley (USNM 22376); GRANT CO.: Mogollon Creek, above falls (UNMCV 159); LINCOLN CO.: 12 mi. NW. Carrizozo (UMMZ 66774); SANDOVAL CO.; E. Sandia Pueblo (UNMCV 413); Pena Blanca (UNMCV 131); 25 mi. N. Albuquerque (UNMCV 163); SIERRA CO.: Lake Valley (ANSP 10786); TORRENCE CO.: Mountainair (UNMCV 411); ARIZONA: COCHISE CO.: 0.5 mi. SW. Portal (UMMZ 119029); Bisbee (CU 4694–5); Pinery Creek, Chiricahua Mts. (AMNH 80807); 2 mi. W. Ft. Huachuca (USMN 102201); Ft. Huachuca (USNM 21061); GILA CO.: Roosevelt (UNMCV 2698–9); PINAL CO.: Camp Grant (USNM 8019); NAVAJO CO.: Ft. Apache (USNM 8427); PIMA CO.: Sabino Canyon, Santa Catalina Mts. (USNM 62569); Sycamore Canyon, Baboquiviri Mts. (ANSP 17998); Otero Canyon, Baboquiviri Mts. (ANSP 17953); Ft. Buchanan (ANSP 3465); SANTA CRUZ CO.: Madera Canyon, Santa Rita Mts. (ANMH 64428); 10 mi. N. Nogales (AMNH 67253); YAVAPAI CO.: White River Canyon (USNM 10199); Camp Verde (AMNH 4202, 62240); UTAH: SAN PETE CO.: Freedom (UMMZ 63999); UTAH CO.: S. Fork West Canyon (BYU 13775, 14168–9, 14672–3); WASHINGTON CO.: Pine Valley (CU 3836); MEXICO: CHIHUAHUA: Maguarichic (UMMZ 118929); 6 mi. E. Barraganes (AMNH 73749); Norogachi (AMNH 73751); 10 mi. W. San Francisco del Oro (BYU 14251); 7 mi. SW. Pacheco (MVZ 46685). *D. p. dugesi*.—MEXICO: HIDALGO: 8 mi. N. Pachuca (UIMNH 17635); JALISCO: 10 mi. W. Guadalajara (UIMNH 46578, 47866); Guadalajara (AMNH 3711-12); W. Ocotlan (AMNH 19723); MEXICO: (AMNH 62827); 3 mi. S. Villa Obregon (UMMZ 99540); MICHOACAN: 2 mi. E. Morelia (AMNH 62827);

15 km. W. Morelia (UIMNH 17634); 5 mi. E. Lake Patzcuaro (UIMNH 17636); NAYARIT: La Labor (AMNH 19724); 7 mi. S. Compostela (AMNH 80590). *D. p. regalis* x *dugesi*.—MEXICO: CHIHUAHUA: 2 mi. E. Cerocahui (BYU 14243); DURANGO: 20 mi. NW. Los Coyotes (UMMZ 102527); 40 mi. SW. Cd. Durango (ISM uncataloged). *D. p. regalis* x *arnyi*.—NEW MEXICO: EDDY CO.: Walnut Canyon, Guadalupe Mts. (CCNP 2197, 2201; UMMZ 122949); TEXAS: BREWSTER CO.: near Alpine (CU 869, 883); near Panther Pass, Chisos Mts. (UNMCV 2701); Upper Green Gulch, Chisos Mts. (UNMCV 2700); CULBERSON CO.: McKittrick Canyon, Guadalupe Mts. (UMMZ 121825, 122948, 122955; BCB 8702).

***Masticophis flagellum lineatulus* Smith**

Since the description of *M. f. lineatulus* (Smith, 1941), in which the specimen from Laguna, Valencia County, was indicated as a paratype, only one additional individual, to my knowledge, has been collected in the Zuni region. It comes from the Plains Life Belt at 6300 feet, where narrow-leaved yucca and one-seed junipers are prevalent. This coachwhip snake may reach the approximate northwestern limit of its New Mexico range at the eastern end of the Zunis. It is presently unknown in McKinley and San Juan Counties, although Maslin (1959, p. 57) saw what he presumed to be *M. flagellum* in adjoining Montezuma County, Colorado.

The recent specimen, an adult male, 1070 mm. in total length, has longitudinal dark lines on the dorsal scales but retains dark anterior cross bands and lacks the diagnostic red subcaudal color. Its subspecific allocation is, therefore, tentative. I must agree with Wright and Wright (1957, pp. 437–438), who remarked on the difficult southwestern members of the *M. flagellum* complex and considered Smith's contribution (1941, pp. 394–397) as tentative.

Locality records:

VALENCIA CO.: Laguna (USNM 4388); 8 mi. E. Grants (TNHC 4487).

***Masticophis taeniatus taeniatus* Hallowell**

Smith and Taylor (1950b, p. 359) apparently overlooked historical circumstances in restricting the type locality of this whipsnake to Shiprock, San Juan County, New Mexico. The actual type locality cannot be determined exactly, but it can be clarified by the following facts. S. W. Woodhouse, accompanying the 1851 Sitgreaves Expedition, collected the form described by Hallowell (1852, p. 181) as *Leptophis taenita* [sic] and later stated by him (Hallowell, 1854, p. 134) to have come from "New Mexico, west of the Rio Grande." Woodhouse came no closer than 100 miles of Shiprock in his journey from Albuquerque to the Zuni Pueblo, but he could have taken *M. t. taeniatus* anywhere in the Rio Grande basin between El Paso and Zuni (Hallowell, 1854, p. 147). Apparently he did not collect snakes west of Zuni, for he was incapacitated partially by a bite from *Crotalus viridis* in that locality.

In color and scutellation the few Zuni specimens do not deviate appreciably from *M. t. taeniatus* as defined by Ortenburger (1928, pp. 25–35); however, two juveniles, 525 and 672 mm. in total length, lack the usual reddish suffusion on the subcaudal surface and have clear, undivided, dorsolateral white stripes on the posterior half of the body. Three individuals were collected or observed in the pinyon-juniper savanna, and one came from the cholla-juniper association. Judging from sight records, this whipsnake is more abundant in open Roughlands environments than the number of museum specimens indicates. The species is particularly adept at escaping capture.

Locality records:

VALENCIA CO.: 5 mi. E. Grants (CU 3052); 10.4 mi. S. Grants (CU 5602); MCKINLEY CO.: Nutria (USNM 8432).

Salvadora grahamiae grahamiae Baird and Girard

Records of *S. g. grahamiae* on the southeastern edge of the Zuni Mountains and at Santa Rosa, Guadalupe County, New Mexico (Bogert, 1939, p. 189), provide the northernmost stations for this species in the United States. Mountain patch-nosed snakes were reported previously from Valencia County by Charles M. Bogert (see Wright and Wright, 1957, p. 649), who informed me (in litt.) that he examined a specimen taken one mile east of Laguna.

The present Zuni specimens are from 6400 feet in a cholla-juniper-dominated section of the Plains-Roughlands continuum. Both have a high number of ventral scales, 199 and 196 for the male and female respectively; subcaudals are 100 and 97, dorsal scale rows are 19–17–13, and the labials are 9/9 except for 8 in the left upper series of the female. The smaller male has no trace of lateral dark stripes, and its dorsal stripes disappear on the basal third of the tail. The female has definite, dark lateral stripes that become diffuse at the anus.

Hartweg (1940) noted that one of two specimens from near Mimbres, Grant County, New Mexico, lacked the lateral stripes, as did specimens from Trans-Pecos, Texas, and southeastern Arizona. Stebbins (1954, p. 501) stated that Bogert had seen intermediates between *S. g. grahamiae* and *S. g. lineata* (sometimes considered a distinct species) in southern Chihuahua and Durango, Mexico. I examined a specimen (UMMZ 118446) from near Sombrerete, Zacatecas, Mexico, that was also intermediate. Thus, it seems that the two races intergrade over an unusually broad area, or that polychromatism exists; I favor the latter explanation.

Locality records:

VALENCIA CO.: 10.4 mi. S. Grants (CU 5655).

***Pituophis melanoleucus affinis* Hallowell x *P. m. deserticola* Stejneger**

In the Zuni region, gopher snakes present a situation resembling the one already described for *Phrynosoma douglassi*. Although the type locality of *P. m. affinis* is probably about five miles from the Pueblo of Zuni (see Woodhouse, 1854, p. 34), the gopher snake population inhabiting this area actually contains intermediates between *P. m. affinis* and *P. m. deserticola*. Klauber (1947, p. 41) reviewed the circumstances of Hallowell's (1854, p. 146) original restriction of type locality to "near the Zuni River, New Mexico." Smith and Taylor (1950b, p. 359) further restricted it to Zuni, McKinley County, New Mexico, apparently overlooking Woodhouse's statement concerning the provenance of the type of *P. m. affinis*.

When Klauber (1947, p. 44) noted that *P. m. affinis* from the Flagstaff-Gallup area was atypical, he seemingly did not consider that intergradation between it and *P. m. deserticola* might extend that far south. Instead, he believed the blend zone to be in the vicinity of the Hopi villages east to Canyon de Chelly, Arizona, on the basis of intermediate specimens available to him. It now appears that the *P. m. affinis* x *P. m. deserticola* zone is much broader. Considering the characters cited by Klauber (1947), examples of both *P. m. affinis* and *P. m. deserticola* have been taken in San Juan and McKinley Counties (Gehlbach, 1956, p. 370), and intermediates come from the Zunis and 33 miles southeast of Laguna, Valencia County (UMMZ 121490). Thus, at least part of the intergrade area extends south and east of the San Juan Basin.

Zuni specimens are intergrades on the basis of color and body and tail blotch counts (table 9). These characters are intermediate when compared to those given by Klauber (1947, table 4) for *P. m. affinis* and *P. m. deserticola*. With the exception of two individuals, reddish-brown anterior dorsal blotches predominate in the sample, but the influence of *P. m. deserticola* is invariably present in the black tail blotches. Two specimens, one with reddish and one with black anterior blotches, have these markings interconnected so that the light interspaces appear as isolated spots. Specimens least typical of *P. m. deserticola*, in having the highest number of dorsal blotches, have black blotches, thus indicating their intermediate status. In view of the sample as a whole, intergradation in every character may be observed, but *P. m. affinis* influence is probably the strongest overall.

Only *Thamnophis elegans* and *Crotalus viridis* were more evident than gopher snakes in the Zunis. *P. melanoleucus* was found usually in the lower two life belts, being least abundant in Roughlands associations. More specimens were taken and observed in saltbush-sage than in any other vegetational type. In the Roughlands life

belt, gopher snakes were encountered in open pinyon-juniper savannas. Two individuals came from a cholla-juniper section of the Plains-Roughlands ecotone, where they were secreted in pack rat nests built among Indian Ruins. A juvenile, 385 mm. total length, collected July 23, 1957, at 7100 feet, was undoubtedly a hatchling as it had a fresh yolk-sac scar.

Of the variety of food items palpated from newly caught specimens, *Sceloporus undulatus*, *Peromyscus* species, *Neotoma* species, *Thomomys bottae*, and various passerine birds predominated. One gopher snake, extracted by the tail from a gopher burrow at 10:35 a.m., was coiled tightly around an adult *Thomomys bottae*. Juveniles sometimes fed upon lizards in the manner of a garter snake, i.e., without first constricting their prey.

Locality records:

MCKINLEY CO.: 4 mi. S. Thoreau (CU 5611); 4 mi. NNE. Prewitt (CU 5589); Ft. Wingate (USNM 8658, 16766–7); Black Rock (CWGF); VALENCIA CO.: 6 mi. SE. Grants (CU 5612); 8 mi. SE. Grants (UMMZ 86632); 16 mi. S. Grants (UMMZ 86631); 5 mi. SSW. U. S. Rt. 66 on N. M. Rt. 117 (CU 5769); 2.5 mi. NE. Ramah (CU 5454); 2 mi. W. El Morro Nat. Mon. (CWGF); El Morro Nat. Mon. (CWGF).

***Hypsiglena torquata texana* Stejneger x *H. t. ochrorhyncha* Cope x *H. t. loreala* Tanner**

In New Mexico, as throughout the Southwest, some subspecies of *H. torquata* seem to me to be poorly defined. This fact and the paucity of specimens from the Zuni region demand that the present intergrade zone be considered provisional. Stebbins (1954, p. 492) has mapped this zone, utilizing subspecies boundaries defined by Tanner (1944). I likewise follow Tanner (1944) but with reservation, in light of the preceding discussion. Bogert and Oliver (1945, pp. 378–381) and others have presented evidence for lumping the species *H. ochrorhyncha* under *H. torquata*.

The Zuni snake, a male, has 172 ventrals, 47 subcaudals, 21–21–17 dorsal scale rows, 1–1 loreals, and approximately 49 large, dark body blotches, all characteristic of *H. torquata texana*, while the Los Lunas specimen, with about 52 body blotches, resembles *H. torquata texana* in color-pattern and *H. t. loreala* or *H. t. ochrorhyncha* in having 15 dorsals posteriorly. UNMCV 79 is also intermediate; it has 2–2 loreals as in *H. t. loreala*, 16 posterior dorsals, and about 69 small dorsal blotches, similar in size (involving less than 20 scales) to those of *H. t. loreala* or *H. t. ochrorhyncha*. Ventral scale counts of the three specimens, 165, 172, and 177, approximate those of *H. torquata texana* or possibly *H. t. ochrorhyncha* rather than *H. t. loreala* (see Tanner, 1944, table 2).

Features in common include the light-tan ground color and medium-olive or brown blotches ringed in interrupted fashion by dark-brown spots. Some dorsal blotches are broken into a zigzag row of separate or annectant spots as in other spotted night snakes examined from New Mexico. The light-tan coloration differs, however, from the medium gray manifest in *H. torquata* from limestone areas in southern New Mexico. Both UNMCV 79 and CU 5067 have continuous neck bands, a feature found in three of seven specimens at hand from southern New Mexico. A complete band is presumably less frequent in *H. torquata texana* than in *H. t. loreala* or *H. t. ochrorhyncha* (Tanner, 1944).

The single Zuni specimen was taken beneath a tan sandstone slab (Wingate) near the lower edge of the pinyon-juniper association at 6800 feet. Large boulders, steep-sided canyons, and such reptiles as *Urosaurus ornatus* and *Crotaphytus collaris* typified the terrain. Another individual was seen in a nearly identical situation at 7200 feet, two miles south of Thoreau, McKinley County, but escaped into a deep crevice.

Locality records:

MCKINLEY CO.: 3 mi. NE. Thoreau (CU 5067).

Comparative material examined:

H. torquata subspecies.—NEW MEXICO: VALENCIA CO.: Los Lunas (USNM 107347); SAN JUAN CO.: Chaco Canyon Nat. Mon. (UNMCV 79); EDDY CO.: Carlsbad Caverns Nat. Park (UMMZ 86163, 121785; CCNP 2409, 2416); CATRON CO.: 1 mi. N. Glenwood (UNMZ 78231); 13 mi. SE. Glenwood (UMMZ) 78232–33).

Crotalus atrox Baird and Girard

A characteristic member of southwestern desert and desert-grassland herpetofaunas, *C. atrox* is another species that probably reaches the northwestern limit of its New Mexico range in the Zuni region. Here it is found only in open plains situations but may range into the Plains-Roughlands continuum. Ecological restriction to the cholla-juniper association was observed south of Grants, where diamondback rattlers were found between the lava flow and edges of surrounding uplands. This snake was absent from the high soil-covered malpais near El Morro National Monument, where *C. viridis* was abundant; a similar situation was observed on the rough Grants malpais. A large adult, collected by William L. Chenoweth on October 17, 1957, was dead on the road in the short-grass association near Prewitt, when the air temperature was about 55° F.

Yarrow (1875, p. 529) first recorded *C. adamanteus atrox* from Ft. Wingate; Cope (1900, p. 1163) and VanDenburgh (1924, p. 227) mentioned this locality, the latter placing it in McKinley County. While diamondback rattlers occur in southeastern McKinley County,

it is doubtful that the specimen in question, if identified correctly, came from the present Ft. Wingate, which is located in the pinyon-juniper association. On the basis of known distribution, it probably originated near San Rafael, Valencia County, where Ft. Wingate formerly was located (Hoffmeister, 1951, p. 34); however, it is possible that the specimen was misidentified, for it was sent alive to the U.S. National Museum by R. W. Shufeldt and, seemingly, was never preserved (D. M. Cochran, in litt.).

Locality records:

MCKINLEY CO.: Prewitt (UMMZ 79308); 8 mi. ESE. Prewitt (CU 5884); VALENCIA CO.: 8 mi. SE. Grants (UMMZ 86633); 10.4 mi. S. Grants (CU 5591); 11.5 mi. SSE. Grants (CWGF); San Rafael (CWGF).

Crotalus molossus molossus Baird and Girard

Chenoweth (1950, p. 534) first indicated that the black-tailed rattlesnake might be present in the Zuni region. Previously, the northernmost New Mexico record was Laguna (LMK 3197), although a smashed individual was seen on the road near Cubero, Valencia County, by Charles M. Bogert (L. M. Klauber, in litt.). This species may range somewhat further north. James S. Findley (pers. comm.) informed me that *C. molossus* has been reported by other observers in the Sandia Mountains, Sandoval County, and near Cuba, Rio Arriba County.

The single specimen, found during the present survey, was dead on the road in Lobo Canyon at approximately 7000 feet on Mt. Taylor. Its anterior color pattern is typical of *C. molossus* from south-central New Mexico, but there are only 12 distinct dorsal blotches, the entire posterior half of the body being uniform olive brown. The specimen has 27 dorsal scale rows at midbody; other counts cannot be ascertained because of its damaged condition.

Locality records:

VALENCIA CO.: 8 mi. NE. Grants (CU 5868); Laguna (LMK 3197*).

Crotalus viridis viridis Rafinesque x *C. v. nuntius* Klauber

Prairie rattlesnakes in the Zuni region present an east-west intergrading situation similar to that of *Crotaphytus collaris*. Specimens collected east of the Apache County, Arizona-McKinley County, New Mexico, border have been considered nominate *C. viridis* previously (Gehlbach, 1956, p. 371; Klauber, 1935, p. 85). In describing *C. v. nuntius* of the Hopi Indian country, Klauber (1935) stated that easterly intergradation of it with nominate *C. viridis* was gradual over a broad zone. He considered specimens from Gallup closest to *C. v. viridis* in coloration but with low ventral scale counts.

When compared with comprehensive data presented by Klauber

(1956, table 2.7), a series of prairie rattlers from the Zunis approximates *C. v. nuntius* in six of eight meristic characters: number of subcaudal scales and tail rings in males, number of ventral scales and tail rings in females, and total scale row and body blotch counts (table 9). Of the remaining two, only the female subcaudal count favors assignment to *C. v. viridis;* the male ventral count is intermediate. Further indications of affinity with *C. v. nuntius* are the number of midtail scale rows (11–15, $\bar{x}$ 12.3$\pm$0.21) and ground color, which is predominately tan or brown rather than greenish.

Fifteen adults average 653 mm. in total length. The largest is 926 mm. and is the only decidedly greenish individual collected or observed. A female, 620 mm. total length, gave birth to six young, measuring 212–228 ($\bar{x}$ 219) mm., on September 21, 1957. Klauber's (1956, table 4.1) data for average size at birth indicate that these young are approximately intermediate between *C. v. viridis* and *C. v. nuntius.*

It is not surprising to note the light-tan to yellow ground color of *C. v. concolor* in a few Zuni specimens. This feature has been reported in San Juan County, New Mexico (Gehlbach, 1956, p. 371). Intergrades between *C. v. viridis, C. v. nuntius,* and *C. v. concolor* probably occur in the San Juan Basin, but this is difficult to demonstrate since *C. v. concolor* is distinguishable from *C. v. nuntius* only by means of coloration.

Two prairie rattlers, UMMZ 121413 from Canyon de Chelly National Monument, Apache County, Arizona, and UMMZ 121412 from White Canyon, San Juan County, Utah, are pertinent to this discussion. Both are small adults, 540 and 485 mm. in total length respectively, alike in their pinkish-brown coloration. The Arizona specimen differs by having white borders around its anterior dorsal blotches and head markings and a dark-brown stripe across the snout. The Utah snake could be *C. v. nuntius* x *C. v. concolor* in view of its color, pattern, and locality, but several of the larger Zuni specimens also lack white-bordered markings. Legler (1960, p. 182) states that dorsal markings are obliterated gradually with age in *C. v. concolor.* Apparently *C. v. viridis* does not penetrate northwestern New Mexico and adjacent Arizona and Utah as mapped by Klauber (1956, fig. 2.6).

Prairie rattlesnakes inhabit a wide range of Zuni environments. While many individuals were taken on lava flows and in the short-grass and saltbush-sage associations, a smaller number were collected in the Roughlands Life Belt. One was found in the ponderosa pine association of the lower Montane Life Belt. *C. viridis* seemingly was outnumbered by *C. atrox* in the lower, more open grassland, especially that dominated by cholla cactus. Juveniles were uncommon in the Plains Life Belt, suggesting that they might be born in the vicinity

of hibernation sites located in rocky uplands. Both juveniles and adults were often active during early morning and late afternoon hours; they contained recently ingested lizards as well as rodents. Two taken at 9:00 and 10:35 a.m., July 7, 1956, at 7200 feet had eaten *Sceloporus undulatus*.

Jon A. Peterson and field companions described (in litt.) a "combat dance" involving two large individuals at 9:00 a.m., July 14, 1959, near Tinaja, Valencia County. The rattlesnakes, each about three feet long, were situated in bright sunlight in the open grassland of the Miocene lava plain at 7400 feet. A few junipers and pinyons were nearby. The snakes were twisted about each other anteriorly in a position vertical to the ground. After several minutes of observation (photographs were taken, which I have seen), the snakes were disturbed; they were not collected.

Locality records:

MCKINLEY CO.: 4 mi. S. Thoreau (CWGF); 6 mi. S. Thoreau (CU 5046, 5446, 5603); 10 mi. NW. Thoreau (CU 5673); 5 mi. NE. Thoreau (CU 5674); 4 mi. NNE. Prewitt (CU 5457, 5633); Prewitt (UMMZ 79392); Ft. Wingate (USNM 8399); 2.5 mi. N. Upper Nutria (KUMNH 45765); 11 mi. W. Ramah (UMMZ 122882); VALENCIA CO.: 1.5 mi. S. Grants (UMMZ 86635); 8 mi. SE. Grants (UMMZ 86634); 10.4 mi. S. Grants (CU 5590); 25 mi. S. Grants (MCZ 62267[a]); Tinaja (CU 5604); Acoma Pueblo (USNM 44483); El Morro Nat. Mon. (CWGF).

Species of Questionable Occurrence

Certain amphibians and reptiles that may occur in the Zunis are currently unrecorded. This undoubtedly obtains for medium to small colubrid snakes in view of the late discovery of *Diadophis punctatus* in the region. *Arizona elegans*, *Elaphe guttata*, *Lampropeltis doliata*, and *Opheodrys vernalis* are present in north-central New Mexico and southwestern Colorado or adjacent Utah and eventually may be collected in or near the Zuni region. The latter two species can be presumed to occur on the basis of observations by local residents. *A. elegans*, collected near Farmington (A. Harris, in litt.), is the only one of these snakes recorded from San Juan County, New Mexico: it has been taken near Madrone, Valencia County (UNMCV 407).

Sceloporus magister, *Crotaphytus wislizeni*, and *Cnemidophorus tigris* also occur in north-central New Mexico and southwestern Colorado. The latter two lizards and *Heterodon nasicus* are characteristic of a type of sandy habitat seemingly lacking in the Zunis. *C. wislizeni* is present near Laguna (USNM 4274), but *C. tigris* has been taken no closer than nine miles south of Shiprock (AMNH 77530) and Blanco, San Juan County, New Mexico (A. Harris, in litt.). *H. nasicus* was collected between Laguna and Correo, Valencia County (UNMCV 391). *S. magister* is known from Montezuma

County, Colorado (Maslin, 1959, p. 30), and Los Lunas, Valencia County (Smith, 1949, p. 156); its apparent absence in the Zunis is enigmatical.

A number of species present in Chihuahuan desert-grassland in extreme eastern Valencia County might be found as far west as Laguna but cannot be expected on the Colorado Plateau. Of these, *Phrynosoma modestum* (UNMCV 1170) and *Cnemidophorus tessellatus* (UNMCV 1169) have been taken near Correo. Semiaquatic forms such as *Thamnophis sirtalis* and *Chrysemys picta* seem more closely restricted to the Rio Grande. *T. sirtalis* was reported from Los Lunas, Valencia County, by Fitch and Maslin (1961, p. 299), and a relict colony of *C. picta* (UMMZ 64916–17) also exists there. That turtles were formerly present in the Zunis is suggested by paintings of them on Zuni Indian pottery (Whipple, 1856, p. 66).[7]

Hyla eximia (=*H. wrightorum*?) listed from Nutria (McKinley County?) New Mexico, by Yarrow (1875, p. 524) has not been collected during the present study. One of the two original specimens (USNM 8508; the other apparently is lost) was examined, but identity could not be verified owing to its poor state of preservation. Also, *P. modestum* and *Bufo cognatus*, recorded from Cottonwood Gulch by Chenoweth (1950), have not been rediscovered despite intensive field work in and around that locality. Since these records are based on one specimen each and the locality is the site of a boys' summer camp, the records are thought to represent introduced individuals.

Zoogeography

The Zuni region is situated on the southeastern edge of the Colorado Plateau adjacent to the northeastern limits of the Basin and Range physiographic province. Its zoogeographic importance is demonstrated by the fact that eight amphibians and reptiles exhibit limited gene flow between intergrading subspecies that are associated better with the Colorado Plateau and other northern areas or the Basin and Range. It is similarly important that six species reach their northern limits of range in the area. To facilitate discussion of these regional patterns, the Zuni herpetofauna may be arranged according to present centers of distribution (table 11); nevertheless, interpretation of past events and causal factors in distribution rests entirely on paleoecological inference in the absence of local fossil records.

[7] Some shells of *Chrysemys picta* (AMNH 19888, 20580) from the pueblo ruins of Hawikuh, 12 miles southwest of Zuni, Valencia County, recently came to my attention. They have not been dated with precision, but it is known that Hawikuh was abandoned around 1670 A. D.

TABLE 11.—*Present centers of distribution of the Zuni herpetofauna*

Transcontinental North America	
Ambystoma tigrinum	*Sceloporus undulatus*
Bufo woodhousei	*Diadophis punctatus*
Pseudacris triseriata	*Masticophis flagellum*
Rana pipiens	*Pituophis melanoleucus*
Western North America	
Scaphiopus intermontanus	*Eumeces multivirgatus*
Crotaphytus collaris	*Thamnophis elegans*
Sceloporus graciosus	*Masticophis taeniatus*
Uta stansburiana	*Hypsiglena torquata*
Urosaurus ornatus	*Crotalus atrox*
Phrynosoma douglassi	*Crotalus viridis*
Cnemidophorus velox	
Mexican Plateau	
Scaphiopus hammondi	*Thamnophis dorsalis*
Bufo punctatus	*Salvadora grahamiae*
Hyla arenicolor	*Crotalus molossus*
Holbrookia maculata	
Great Plains	
Scaphiopus bombifrons	*Eumeces obsoletus*

Patterns of Distribution

Three widespread species, *Sceloporus undulatus*, *Urosaurus ornatus*, and *Hypsiglena torquata*, contain one geographic race restricted to the greater Colorado Plateau region and another to the southeastern Basin and Range province. These intergrade in the Zunis and elsewhere along the southern border of the Plateau.[8] *Bufo woodhousei*, *Pseudacris triseriata*, *Uta stansburiana*, *Eumeces multivirgatus*, and *Pituophis melanoleucus*, from the same distributional groups (transcontinental and western North America), have similar patterns of restricted gene exchange, but their northern subspecies are in no sense limited to the Plateau. It is significant that a past or present break in the gene flow of these eight eurytopic forms coincides with the Colorado Plateau-Basin and Range border.

Scaphiopus bombifrons and *Eumeces obsoletus*, the two Great Plains species, and *Salvadora grahamiae* and *Crotalus molossus*, centered on the Mexican Plateau, are at or near the northern limits of the southwestern portions of their range in the Zunis. They have not penetrated Colorado Plateau highlands except along a few major river valleys. The five other species allied with the Mexican Plateau range somewhat further north but not beyond the upper Colorado River

[8] *Holbrookia maculata* and *Crotalus viridis* also may fit this pattern in part, but the Colorado Plateau subspecies involved are defined inadequately at present.

basin. *Crotalus atrox* and possibly *Masticophis flagellum* also reach northern limits in the Zuni region. They are the only two species from the transcontinental and western North America groups that inhabit semiarid lowlands south of and, in the case of *M. flagellum*, east and west of the Colorado Plateau.

No species of reptile or amphibian present in the Zunis is restricted to the Colorado Plateau, and none are definitely limited to it at their southern edge of range. *Cnemidophorus velox* is distributed largely within Plateau boundaries but also ranges into the Basin and Range province. The main distribution of *Sceloporus graciosus* apparently coincides with the southern border of the Plateau in New Mexico although relict colonies exist much farther south. *Scaphiopus intermontanus* may reach its southern limits in the Zuni region, but is known too poorly in New Mexico to be of zoogeographic value. It appears, therefore, that Colorado Plateau environments have been more effective in limiting northward dispersal than in preventing movement southward.

Physiographic continuity of the southern Plateau (Datil and Navajo Sections) across the Zuni region is in sharp contrast to the north-south break between the Plateau and Basin and Range south and, to some extent, southeast of this area. This situation does not favor east-west geographic differentiation but allows gene flow between subspecies that previously might have been better isolated. The intergradation patterns, thus, of *Crotaphytus collaris* and *Crotalus viridis* might be expected to differ in degree from those of the aforementioned species. There is reason to suspect that relatively smooth character gradients are present in the east-west pattern and that sharper breaks are involved in the more common north-south pattern.

The remaining eurytopic species, *Ambystoma tigrinum*, *Rana pipiens*, *Phrynosoma douglassi*, *Thamnophis elegans*, *Diadophis punctatus*, and *Masticophis taeniatus*, are distributed throughout the Zunis, the Colorado Plateau, and bordering Basin and Range province with little apparent regional differentiation. While geographic variation occurs elsewhere, the demonstrated local barriers to dispersal are relatively unimportant in each of these species.

Paleoecology and Dispersal

As indicated by species adaptation and rather close restriction to modern environments, development of the Zuni herpetofauna—indeed, that of the entire Southwest—followed closely upon the formation of recent topography and semiarid vegetation in the late Cenozoic. Differentiation of the Colorado Plateau from a relatively flat plain began in the Miocene, and epeirogenic uplift has continued into the Pliocene and Pleistocene, raising the Plateau above basins to the

south and west (Hunt, 1956, pp. 73–86). The ranges of certain widespread species undoubtedly were fragmented first by these upheavals and by the climatic changes that followed.

Dry, warm, middle Pliocene climates produced grassland and subdesert environments of great extent (Axelrod, 1948). Present regional adaptations such as time of egg-laying may have originated then in response to increasing aridity. It is probable that ensuing dry conditions permitted northward dispersal of amphibians and reptiles adapted to vegetative environments of the expanding Madro-Tertiary Geoflora and that montane species associated with forests of the Arcto-Tertiary Geoflora simultaneously were limited. Axelrod (1950, 1958) and Darrow (1961) have reviewed the history of these major geofloras.

Many neontologists, including myself, believe that present plant and animal distributions were slightly to highly modified by violent climatic fluctuations during the Pleistocene. Considerable modification of the extent of plant communities characterized this epoch. Evidence presented by Antevs (1954), Clisby and Sears (1956), Leopold (1951a), Murray (1957), and Wendorf (1961) in New Mexico suggests that grassland and desert species withdrew southward at or about the time of glacial advance and that woodland forms then dispersed across former semiarid zones.

Periglacial deposits are extensive on Mt. Taylor (Hunt, 1956, p. 38), indicating that the Zuni region was not excluded from Pleistocene climatic change. Glacial deposits have been recognized along the north, east, and south sides of the Colorado Plateau; these extend down to 7000 or 8000 feet in some areas (Hunt, 1956, p. 35). Martin, Sabels, and Shutler (1961, p. 115) postulated that during a cool-moist interval the pinyon-juniper savanna was displaced downward 1700 feet in the Grand Canyon, Arizona, or, in terms of life zones, was 2000–4000 feet below its present lower limits. If Zuni life belts were uniformly lower by 4000 feet at such a time, as Antevs (1954) has estimated for lowered life zones at Santa Fe, then the present Plains Life Belt with its characteristic species did not exist.

Zuni life belts probably fluctuated in a manner similar to those diagramed by Martin (1961, fig. 2); thus, plains species like *Scaphiopus bombifrons* and *Holbrookia maculata* were absent when cool-moist conditions favored heavy forests or open woodland at low elevations but may have been present prior to such forestation. Coincidently, woodland-canyon species such as *Hyla arenicolor* or *Eumeces multivirgatus* were provided new pathways for dispersal. The opposite situation existed during warm-dry intervals; hence, woodland forms have had the most limited gene flow in Hypsithermal time and presumably within the past century. While such "alternating

genetic currents" are purely speculative, they are in accord with paleoecological and neoecological evidence. It is significant that the north-south patterns of Pleistocene climatic change and local physiographic differentiation augment each other in affecting dispersal.

If cool-moist intervals limited the northward movement of widespread, grassland species, they were equally potent in restricting desert and desert-grassland forms like *Crotalus atrox*. No great changes in drainage pattern have occurred on the Colorado Plateau since the late Pliocene (Hunt, 1956, p. 85), but the Rio Grande valley of southern New Mexico did not exist as a lowland pathway for north-south dispersal prior to early mid-Pleistocene time (Ruhe, 1960). Are some species that reach their northern limits in the Zuni region, therefore, postglacial invaders? Dowling (1956) accounted for the presence of similar xerically adapted species in Arkansas by postulating recent immigration from the Great Plains during a Holocene arid interval.

What about the distribution of such vagile forms as *Ambystoma tigrinum* and *Thamnophis elegans*? It seems possible that at least some of them remained locally at lower elevations on the Colorado Plateau during the Pleistocene climatic shifts. This is suggested by Tihen's description (1942) of neotenic *A. tigrinum* in Great Plains glacial deposits and typical metamorphosed individuals in interglacial sediments. Many of the other widespread species are equally adaptable and some like *Phrynosoma douglassi*, in addition to *A. tigrinum* and *T. elegans*, are relatively abundant in both Montane and Plains Life Belts.

Summary

Between 1951 and 1961, the systematics, ecology, and life history of 30 species of amphibians and reptiles were studied in the Zuni Mountains region, McKinley and Valencia Counties, New Mexico. This area, characterized by extremes of temperature and midsummer rainfall, contains Plains, Roughlands, and Montane Life Belts, and extensive lava flows. Elevations range from 5794 feet at Laguna on the eastern end of the study area to 11,389 feet at the top of Mount Taylor. Unfortunately, man has drastically altered natural environments. Drought pervades the recent climatic history of the region.

Of 19 common species, no two have the same vertical distribution or relative abundance. Five lizards of similar adult size have different morphological and physiological adaptations and occupy different habitats. In the Iguanidae, scansorial species such as *Urosaurus ornatus* have more lamellae than terrestrial species like *Phrynosoma douglassi*. Oviposition in *Holbrookia maculata*, *Sceloporus undulatus*, *Sceloporus graciosus*, and *U. ornatus* seems to be correlated with

the onset of summer rainfall. *Scaphiopus hammondi*, *Crotaphytus collaris*, and *U. ornatus* are darkly colored on lava. Similarly, *H. maculata* and *S. graciosus* are very light on white sand, but none of these species exhibit geographically unique coloration.

Scaphiopus bombifrons, *Scaphiopus intermontanus*, *Eumeces obsoletus*, *Salvadora grahamiae*, *Masticophis flagellum*, *Crotalus atrox*, and *Crotalus molossus* reach their limit of range in the Zuni region. Subspecific intergradation occurs in *Bufo woodhousei*, *Pseudacris triseriata*, *Crotaphytus collaris*, *Sceloporus undulatus*, *Uta stansburiana*, *Urosaurus ornatus*, *Eumeces multivirgatus*, *Pituophis melanoleucus*, *Hypsiglena torquata*, and *Crotalus viridis*. In certain cases, distributional patterns may have been modified by climatic changes and the Colorado Plateau-Basin and Range physiographic break located immediately south and southeast of the Zuni region. The Plains Life Belt apparently was eliminated during cool-wet periods of the Pleistocene, and woodland environments were restricted during warm-dry intervals.

Ambystoma tigrinum stebbinsi and *A. t. utahense* are synonymized with *A. t. nebulosum*, *Holbrookia maculata ruthveni* with *H. m. approximans*, and *Phrynosoma douglassi ornatissimum* with *P. d. hernandesi*. *Diadophis regalis* and *D. dugesi* are considered to be subspecies of *D. punctatus;* the ranges of these forms and the western limits of *D. p. arnyi* are clarified. Detailed accounts of variation in *A. t. nebulosum*, *Cnemidophorus velox*, and southwestern and Mexican *Diadophis* are presented. Environmental and ontogenetic variation are given special emphasis, and a graphic method for illustrating the latter is offered in the discussion of *E. multivirgatus*.

Addenda

In preparing the account of recent environmental changes, I overlooked an important paper by Leopold (1951b) containing a highly pertinent summary of some nineteenth-century observations of Zuni environments. Also instructive are two photographs (Leopold, 1951b, fig. 1) of an area near Fort Wingate showing encroachment of sagebrush on grassland between 1901 and 1946.

The revised manuscript was completed in December 1961. Since then, Smith and Williams (1962) have shown that the names *Eumeces multivirgatus gaigeae* and *Thamnophis crytopsis* are conserved by application of the nomen oblitum rule of the 1961 International Code of Zoological Nomenclature.

McCoy (1962) corrected Maslin's record (1959) of *Crotalus viridis viridis* in Montezuma County, Colorado; he identified three specimens from Mesa Verde as *C. v. nuntius*. Additional support for intergradation between the subspecies *C. v. viridis*, *C. v. nuntius*, and *C. v. concolor*

in the San Juan Basin of northern San Juan County, New Mexico, and adjacent Colorado was offered by Dean and Stock (1961).

New evidence for considering *Diadophis dugesi* as a subspecies of *D. punctatus* was presented by McCoy (1964), who recorded a female from Durango, Mexico. His specimen is intermediate between the subspecies *D. p. regalis* and *D. p. dugesi* in ventral count (212) but resembles the latter in number of subcaudals (68) and dorsal scale rows (17–17). As I have shown, number of ventral scales is the most diagnostic feature separating southwestern and Mexican races of ringneck snakes.

Dean and Stock (1961) reported *Crotaphytus collaris auriceps* in extreme northern San Juan and Rio Arriba Counties, New Mexico (San Juan Basin). If *C. c. auriceps* is indeed recognizable, then Zuni specimens seem to show a slight relationship with this form based on labial counts. It would be desirable to pursue other meristic features that might distinguish *C. c. auriceps*.

A brief report by Maslin (1962) on all-female species of *Cnemidophorus* includes *C. velox*. The possibility of parthenogenesis is suggested; and two males of *C. velox*, possibly the ones I examined and thought close to *C. inornatus*, are mentioned. Maslin also considers their allocation questionable.

Harris (1963) contributed data on the ecological distribution of reptiles and amphibians in the San Juan Basin. He recorded *Scaphiopus bombifrons* and *Cnemidophorus inornatus* in San Juan County, New Mexico, and elaborated other records contained herein and attributed to him. That the taxonomic relationships of *S. bombifrons* with *S. intermontanis* and *C. velox* with *C. inornatus* need investigation becomes increasingly apparent.

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REVIEW OF THE GENUS CERCERIS IN AMERICA NORTH OF MEXICO (HYMENOPTERA: SPHECIDAE)

By HERMAN A. SCULLEN

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REVIEW OF THE GENUS CERCERIS IN AMERICA NORTH OF MEXICO (HYMENOPTERA: SPHECIDAE)

By Herman A. Scullen [1]

Introduction

The wasp tribe Cercerini as recognized in this country (Muesebeck, Krombein, and Townes, 1951) consists of the two genera *Cerceris* Latreille (1802) and *Eucerceris* Cresson (1865). The former is well represented in all continental areas while the latter is limited to North America.

The earliest references to the genus *Cerceris* in North America were by Thomas Say when he published descriptions of the following species: *frontata* Say (1823), *deserta* Say (1825), *fumipennis* Say, (1837) and *sexta* Say (1837). Numerous species have been described since the publications of Say. In 1865 E. T. Cresson monographed the Family Philanthidea of North America, which at that time included the genus *Cerceris* and the new genus *Eucerceris*. Cresson published over 20 papers relating to Cercerini and described a total of 20 species recorded from north of the Mexican border. In 1912 Nathan Banks published his first paper on the genus *Cerceris*. This was followed by eleven additional papers. In all, Banks described 52 species of

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Cerceris north of the Mexican border. In spite of the fact that many of Bank's species have proven to be synonyms, his contribution has been outstanding. The work of H. S. Smith and C. E. Mickel in Nebraska is worthy of special note. In describing new Mexican species, Saussure (1867) and Cameron (1890) included several species found subsequently to range north of the Mexican border. Numerous other workers have added one or more species to the present list.

A summary of all contributors (with the number of species described and their principal publication dates in parentheses) is as follows: Say (4, 1823, 1825, 1837); Spinola (1, 1841); Dahlbom (2, 1845); Guérin (2, 1845); F. Smith (4, 1856); Cresson (20, 1865, 1872); Packard (1, 1866); Saussure (6, 1867); Taschenberg (1, 1875); Patton (1, 1880); Schletterer (1, 1887); Provancher (1, 1888); Cameron (4, 1890, 1904); Fox (2, 1893); Cockerell (1, 1897); Viereck (1, 1902); Viereck and Cockerell (17, 1904); H. S. Smith (2, 1903); Rohwer (6, 1908, 1920); Banks (52, 1912, 1913, 1915, 1916, 1917, 1919, 1923, 1947); Mickel (15, 1916, 1917); Brimley (5, 1927, 1928, 1929).

Fourteen new species and 12 new subspecies are described by the author in the present paper.

BIOLOGY.—Members of the genus *Cerceris* are solitary in their nesting habits although several females usually are found nesting close together. The grouping of several nests in the same area has been considered to be the result of the suitability of soil conditions and the availability of food for both larvae and adults. Krombein's observations (1936) on *C. nigrescens* F. Smith, however, indicate there are exceptions. Apparently the adults feed solely on nectar and pollen, while the larvae are fed beetles.[2] Only a limited number of species of *Cerceris* have been studied carefully to determine their nesting and feeding habits. Most species of *Cerceris* use some species of weevil to feed their young. On the other hand, the females of Group II are known to use Buprestidae. Both species forming Group IV (*macrosticta* Viereck and Cockerell and *femurrubrum* Viereck and Cockerell) are known to use Tenebrionidae. Recently, Werner (1960) reported *C. truncata* Cameron using three species of Bruchidae in Arizona. *C. convergens* Viereck and Cockerell also has been recorded collecting *Bruchus* sp. in southern California. Several species of *Cerceris* have been found to collect Chrysomelidae.

One observation recorded by J. C. Bridwell in unpublished notes is of special interest. Females of *C. fumipennis* Say under observation at Clifton, Virginia, were found "to be storing their nests with adult

[2] Some European species of *Cerceris* are known to store solitary bees as food for their young. For a brief discussion and references, the reader is referred to Linsley and MacSwain (1956, p. 72). The records of *Cerceris* collecting insects other than beetles in this country are open to question.

beetles of the genus *Chlamisus*, a Chrysomelidae resembling Buprestidae only in their hard integument and their metallic luster." This change of prey took place after Buprestidae ceased to fly.

Two unpublished records (Princeton, N.J., July 5, 1948, by K. W. Cooper, and Winchester, Va., July 23, 1961, by Frank Kurczewski) of *C. clypeata* Dahlbom taking *Lema trilineata* Oliver, a Chrysomelidae, have come to the writer's attention. *C. clypeata* normally takes weevils.

Noteworthy published contributions in the field of *Cerceris* biology north of Mexico are summarized briefly below.

The Peckhams (1898, pp. 108–117) report observations made on *C. clypeata* Dalhbom, *C. deserta* Say, and *C. nigrescens* F. Smith. *C. clypeata* Dahlbom was seen taking *Balaninus nasicus* Say. *C. deserta* Say was reported taking *Conotrachelus posticatus* Boheman. From Peckham's statement that *C. deserta* Say "closely resembles *clypeata*," it would appear the observations were made on a species other than the one accepted as *deserta* Say by Cresson, the present writer, and others (see p. 478). The above beetles are Curculionidae. The prey of *C. nigrescens* F. Smith was not recorded. In 1900 (p. 90) the Peckhams published a brief note on *C. fumipennis* Say found nesting in Wisconsin. This wasp was found collecting *Chrysobothris 4-impressa* Castelnaw.

Hartman (1905, p. 66) in reporting briefly on the nesting habits of *C. fumipennis* Say indicates it was collecting the weevil *Conotrachelus neocrataegе*.[3] This species of wasp usually takes Buprestidae.

Grossbeck (1912a, p. 135) reported briefly on observations made at Yaphank, Long Island., N.Y., in 1911 on nesting *Cerceris fumipennis* Say. He reported the wasp storing the following Buprestidae: *Dicerca punctulata* (Schönherr), *Buprestis lineata* Fabricius, and *Chrysobothris floricola* Gory.

Rau and Rau (1918), reporting on field studies near St. Louis, Mo., record the activities of *C. fumipennis* Say (pp. 126–127) and *C. finitima* Cresson (p. 133). The former wasp was found using *Argilus objectus* Horn (Buprestidae). The prey of the latter wasp was not recorded. It was found to have made a nest in the pith-chamber of a weed-stalk although the Raus had noted it earlier entering holes in the ground as is usual for the genus. Rau (1928, pp. 325–341) reports detailed studies of *C. raui* Rohwer (=*C. frontata raui* Rohwer), which he found nesting at Jerseydale about thirty miles south of St. Louis, Mo. This wasp was found using *Thecesternus humeralis* Say and *Lixus concavus* Say. Rau here reports also on his studies of *C. bicornuta* Guérin, which was using three species of billbugs, *Spheno-*

[3] *C. neocrataegе* is not a valid name in the genus *Conotrachelus*. Correct identification of the material Hartman had is not possible.

phorus placidus (Say), *S. zeae* Walsh, and *S. parvulus* Gyllenhal. The cuckoo-wasp *Hedychrum violaceum* Brullé was seen entering the *bicornuta* burrow. On page 338, Rau reports that *C. finitima* Cresson "make nests in twigs," but the present writer finds no other record of this or any other species of *Cerceris* nesting in twigs.

In 1928 (pp. 205–206) Abbott reported observations on the nesting and prey of *Cerceris architis* Mickel (=*C. halone* Banks), which he found nesting at Elgin, Ill. This wasp was using *Curculio nasicus* Say as food for its young.

In 1929 (p. 35) Cartwright reported *C. bicornuta* Guérin provisioning its nests with the maize billbug *Calendra maidis* Chittenden. Cartwright in 1931 (pp. 269–270) reported some observations at Jocassee, S.C., on *C. fumipennis* Say, which he found collecting the beetle Buprestidae. Specimens of these beetles found about the wasp's nesting area numbered 136 and represented 20 species that he listed by name. At the same time, he reported seeing a specimen of *C. mandibularis* Patton bringing in a grasshopper nymph. This unusual prey record needs verification.

Strandtmann reported briefly in 1945 (pp. 311–312) observations of three species of *Cerceris* in Ohio. *C. serripes* Fabricius (=*C. bicornuta* Guérin) was reported collecting a weevil, *Calandra* sp.; *C. rufinoda* Cresson, the weevil *Tychius picirostris* (Fabricius); *C. finitima* Cresson, a black flea beetle, *Cheatocnema pulicaria* Melsheimer.

Krombein has taken advantage of the opportunity to study the biology of several species of *Cerceris* over the past years. In 1936 (pp. 93–99) he reported observations made of *C. nigrescens* F. Smith at Buffalo, N.Y. He found this wasp provisioning its nest with *Hyperodes delumbis* Gyllenhal and *Sitona hispidula* Fabricius. A sarcophagid (*Senotainia trilineata* Van der Wulp) was seen shadowing the wasp. In 1938 (pp. 1–3) Krombein reported subsequent observations at Buffalo on *C. nigrescens* F. Smith, where the wasp was found to be using the beetles *Sitona hispidula* (Fabricius), *Gymnetron antirrhini* Paykull, *Gymnetron* sp., and *Hyperodes delumbis* (Gyllenhal), all of which are Curculionidae.

In 1950 (pp. 147–149) Krombein reported studies of a colony of *C. robertsonii* Fox at Kill Devil Hills, N.C. This species of wasp was found provisioning its cells with a chrysomelid (*Rhabdopterus picipes* (Oliver)). *Metopia leucocephala* (Rossi), a parasitic sarcophagid fly was reared from the wasp cell. Subsequent studies by the same worker in 1952 at Kill Devil Hills, N.C. (1953, pp. 113–121), showed this wasp to be collecting *Cryptocephalus notatus* Fabricius and *Pachybrachis dilatatus* Suffrian (Chrysomelidae). At the same location he reported *C. bicornuta bicornuta* Guérin taking the following weevils: *Calendra venata venata* (Chittenden) and *C. cariosus* (Oliver). A more

extensive report on the nesting habits of *C. robertsonii* Fox is given by Krombein in 1952c (pp. 288–294). This same worker (1956, p. 43) published a brief note on the nesting of *C. atramontensis* Banks at Dunn Loring, Fairfax Co., Va., in which he reported the wasp collecting the weevils *Conotrachelus posticatus* Boheman and *C. naso* LaConte.

In 1958 (p. 110) Krombein reported observations on the nesting of *C. fumipennis* Say at Kill Devil Hills, N.C., where he found the wasp utilizing the buprestids *Chrysobothris femorata* (Oliver) and *Dicerca lurida* (Fabricius) as food for its young.

In 1958 Krombein found a colony of *Cerceris flavofasciata* H. S. Smith nesting at Kill Devil Hills, N.C., in a vertical sand bank (1959, pp. 197–198). These wasps were found to be using as prey for their young the following chrysomelid beetles: *Cryptocephalus guttulatus* Oliver, *C. mutabilis* Melsheimer, *Cryptocephalus* sp. (probably *quadrimaculatus* Say), *Bassareus clathratus* (Melsheimer), *Bassareus* sp. (probably *sellatus* Suffrian), and *Chlamisus* sp. (probably *plicata* (LeConte)). A mutillid, *Dasymutilla nigripes* (Fabricius), was reared from a cocoon of the wasp.

In 1959 Krombein (1960a, pp. 75–77; 1960b, pp. 299–300) studied the nesting habits of *C. bicornuta fidelis* Viereck and Cockerell and *C. frontata frontata* Say at Portal, Ariz. The former wasp was found to be storing a weevil, *Eupagoderes* sp.; the latter wasp was storing *Cleonus pulvereus* (LeConte) and *Eupagoderes* sp.

In 1956 Linsley and MacSwain published extensive studies of the nesting and prey collecting habits of *Cerceris californica* Cresson, which they found at San Dimas Experimental Forest and Range Experiment Station, San Gabriel Mountains, Calif. These workers found *C. californica* Cresson using a total of 24 species of Buprestidae as prey to feed their young. Considerable information also is included on the parasites of the wasp. These include *Dasymutilla coccineohirta* (Blake) and the following sarcophagids: *Metopia leucocephala* (Rossi), *Amobia floridensis* (Townsend), and *Senotainia trilineata* (Van der Wulp). This is the most extensive report on the biology of a single species of *Cerceris*.

Wasbauer (1957, p. 131) published a brief note on the biology of *C. athene* Banks (= *C. femurrubrum athene* Banks) at Mecca, Riverside Co., Calif. The prey taken by this wasp was a tenebrionid (*Eurymetopon rufipes* Eschscholtz). It is significant that *C. macrosticta* Viereck and Cockerell, also belonging to Group IV, is known to collect Tenebrionidae in Colorado and Arizona. From Wasbauer's observations it was found that *C. athene* Banks is the female of *C. femurrubrum* Viereck and Cockerell (see p. 436).

Werner (1960, pp. 43–44) published his observations on a nest of *Cerceris truncata* Cameron found nesting in his own yard. This wasp

was found to be storing its cells with four species of native Bruchidae (Mylabridae): *Algarobius prosopis* (LeConte), *Mimosestes protractus* (Horn), *M. amicus* (Horn), and *Neltumius arizonensis* (Schaeffer). Rau (1933, pp. 164–165) also reports a wasp (*Cerceris* near *mexicana* Saussure) as collecting *Bruchus*.

Krombein (1963, pp. 72–79) published his observations on nests of *Cerceris blakei* Cresson nesting in Florida. This was found to be storing its cells mostly with the weevil *Derelomus basalis* LeConte but was also taking the weevils *Limnobaris confusa* Bocheman, *Anthonomus sexguttatus* Dietz, and *Hyperodes* sp. Less commonly taken were the chrysomelid *Graphops floridana* Blake and the tenebrionid *Blapstinus interruptus* (Say).

Cazier presently is conducting careful studies into the biology of several species of Cercerini at Portal, Ariz. It is probable that some of his studies will be reported before this publication appears.

Byers (1962, pp. 317–321) reports finding a colony of *Cerceris halone* Banks nesting at Mountain Lake Biological Station on Salt Pond Mountain near Pembroke in Giles Co., Va., in the summer of 1961. This wasp was collecting *Curculio nasicus* (Say) as prey for its young. The cuckoo wasp, *Hedychrum violaceum* Brulle, was observed entering the wasp nest. At least three species of sarcophagid flies were reported seen in the nesting area.

Several of the above investigators have made it a point to determine if the beetle prey is killed by the sting of the wasps or if it merely is paralyzed. From the published reports it would appear there is no consistency in this matter even with an individual wasp or within the same species.

Numerous floral visiting records are included on the labels of specimens studied by the present writer. These and his own observations show that most, if not all, species of *Cerceris* have their preferences as to flowers visited for food by the adults. Open types of flowers with a liberal supply of pollen seems to be the usual preference. When the collector or student of *Cerceris* is looking for specimens in the field, it is important to keep in mind this floral preference and to remember that the different species of *Cerceris* may be visiting different species of flora in the same locality at the same time. A record of the flora on which they are collected is desirable. The flora from which they may be collecting beetle prey may be quite different from the flora visited for food by the adults.

MORPHOLOGY AND TAXONOMIC CHARACTERS.—(Plate 1). The writer has found most of the descriptions of older species very inadequate. For this reason and to make the descriptions uniform, all former species have been redescribed. Illustrations have been provided wherever it seemed desirable to clarify characters used.

Color shades and color patterns that have been used extensively by earlier describers are used by the writer to a more limited extent. He has found the color markings of some parts are far more stable than those on other parts within the same species. Futhermore, the overall tendency for color markings to vary is different for different species. One of the most extreme cases of color variation within a species is *C. californica* Cresson. Since, in some cases, the color changes are associated closely with geographical distribution, it seems desirable to recognize subspecies.

In the females the form of the clypeal process and clypeal border continue to be the most important characters to use in separating species. For the males, the relative width of the hair lobes on the clypeus is important in separating groups but not individual species. Denticles on the mandibles, which were seldom mentioned by earlier workers, have been found of value in numerous cases. Other characters seldom or never mentioned by former workers but found useful by the writer are the form and sculpturing of the tegulae, the sculpturing of the enclosure, the mesosternal process, and the form of the pygidium. The form of the pydigium has been of special value in separating females. Extensive studies have been made of the male genitalia in an effort to find more dependable characters to help in their identification. Noticeable differences are found when comparing the males of one group with those of another, but, when species are otherwise closely related, no usable differences have been found.

In general, the writer has found it far more difficult to separate males than females. Even in some cases wherein the males definitely have been recognized by their association with known females, no characters as yet have been found that will separate them. Here is an important field of study in this genus that should be pursued.

Natural subdivisions.—Structures and biological behavior show certain natural divisions within the genus *Cerceris*. In the present publication the writer recognizes five more or less distinct groups. Further study may show that some or all of these groups are sufficiently distinct to warrant recognition as subgenera. For the present, it seems desirable simply to separate them as groups. Other natural subdivisions, not herein recognized, may appear with further studies. Future structural and field biological studies may help in separating distinct groups. Ungrouped species are arranged alphabetically separate from the groups. The characters of each group are presented under each heading.

Material studied.—Through the kind cooperation of many persons, the writer has been able to study well over ninety percent of the material from north of Mexico now found in the collections of this country and also many collections in Europe. Over 40,000

specimens have been made available to him. Type material in the museums of this country has been studied on several occasions, and, with the aid of a grant from the National Science Foundation, the writer was able to study types from this hemisphere deposited in European institutions.

The following institutions have loaned material for these studies:

Academy of Natural Sciences of Philadelphia, Philadelphia, Pa.
American Museum of Natural History, New York, N.Y.
Arizona State University, Tempe, Ariz.
Boston Society of Natural History, Boston, Mass.
Brigham Young University, Provo, Utah
Brooklyn Museum, Brooklyn, N.Y.
California Academy of Sciences, San Francisco, Calif.
Canadian National Collection, Ottawa, Canada
Carnegie Museum, Pittsburgh, Pa.
Centre de Recherches Agronomiques de L'Etat, Gembloux, Belgium
Clemson College, Clemson, S.C.
Colorado State University, Fort Collins, Colo.
Cornell University, Ithaca, N.Y.
Deutsches Entomologisches Institut, Berlin, Germany
Emory University, Atlanta, Ga.
Hancock Foundation, University of Southern California, Los Angeles, Calif.
Harvard University, Museum of Comparative Zoology, Cambridge, Mass.
Illinois Natural History Survey, Urbana, Ill.
Instituto Technologico y de Studios Superiores, Monterrey, Mexico
Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium
Iowa State University, Ames, Iowa
Kansas State University, Manhattan, Kans.
Los Angeles County Museum, Los Angeles, Calif.
Louisiana State University, Baton Rouge, La.
McGill University, Redpath Museum, Montreal, Canada
Michigan State University, East Lansing, Mich.
Milwaukee Public Museum, Milwaukee, Wisc.
Montana State College, Bozeman, Mont.
Museum Histoire Naturelle, Geneva, Switzerland
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Key to the Species of *Carceris*

FEMALES

1. Stigma dark amber or black; mesosternal process usually present; species mostly small . . . . . GROUP I
   Stigma light amber; mesosternal process absent; species mostly medium to large 2
2. Clypeus without a distinct medial elevation or process on the surface of the medial lobe; a pair of small tubercuil (sometimes very indistinct) on the surface of the medial clypeal lobe just above the border; entire border of the clypeus without denticles . . . . . GROUP II
   Clypeus with a distinct medial elevated process (sometimes little more than a ridge but not just a convex area) on the medial lobe; distinct extensions or denticle-like processes on the clypeal free border 3
3. Clypeal process with a lamella or lamellae on the free border . . GROUP III
   Clypeal process without a lamella or lamellae on the free border 4
4. Pygidium not narrowing to an acute or near-acute base (sides may converge slightly basally) 5
   Pygidium narrowing basally to an acute or very narrow end 36
5. Elevation on the medial lobe of the clypeus is cone shaped or with the distal end very much narrowed and without a distinct overhang 6
   Elevation on the medial lobe of the clypeus with a definite overhang; the sides of the process may diverge, converge, or be subparallel 7

6. Entire medial lobe of the clypeus elevated into a cone flanked by single but less prominent pointed processes on each lateral lobe . . . . GROUP IV
Clypeal elevation or process not flanked by smaller processes on the lateral lobes . . . . . GROUP V
7. Lateral apices of the clypeal process considerably prolonged, giving the appearance of horns or the points of a new moon 8
Lateral apices of the clypeal process, if any, not greatly prolonged . . . 12
8. Secondary lateral apices on the sides of the clypeal process . **alceste** Mickel
No secondary lateral apices on the sides of the clypeal process 9
9. Small species, approximately 10 mm. in length . . . . **dentifrons** Cresson
Species of medium to large size, 15 mm. or more in length 10
10. Distinctly black with creamy white markings . . . . **stigmosalis** Banks
Black with yellow markings 11
11. Apical mandibular denticle subequal to or smaller than the other denticles; distance between apical and medial denticles about one-half mm., medial and basal denticles confluent; clypeal process horns very long, curved, and acute; no yellow on the 6th tergum (Central States) . . . **sexta** Say
Apical mandibular denticle noticeably larger than the other denticles; distance between all denticles subequal; 6th tergum yellow to the sides of the pygidium (west of the Rocky Mountains and into Mexico).
tepaneca Saussure
12. Clypeal process width subequal to or greater than the length 13
Clypeal process noticeably longer than the width 27
13. Clypeal process very short, little more than a curved carina 14
Clypeal process length subequal to its width 15
14. Length 13 to 15 mm.; band on tergum 2 much broader than other abdominal bands but deeply emarginate . . . . . **halone** Banks
Length 10 to 11 mm.; bands on terga 2 to 5 subequal . . . . . **deserta** Say
15. Clypeal process relatively flat above 16
Clypeal process convex above 18
16. Free margin of the clypeal process showing very little emargination, lateral apices not acute, minute medial denticle on the margin (Eastern States from Kansas to the New England States) . . . . . **banksi** Scullen
Free margin of the clypeal process with considerable emargination, lateral apices acute, margin without a medial denticle 17
17. Legs amber with no yellow markings (Texas) . . . . . **texana** Scullen
Hindfemora largely yellow with amber at the apical end only (Central Plains States from North Dakota to Texas) . . . **occipitomaculata** Packard
18. Sides of clypeal process subparallel 19
Sides of clypeal process converging 21
19. Creamy yellow markings (Northern States from coast to coast).
nigrescens nigrescens F. Smith
Yellow markings 20
20. Somewhat more robust; lateral apices of clypeal process less acute (California and bordering states) . . . . . **nigrescens munda** Mickel
Lateral apices of the clypeal process very acute (Northeastern States).
nigrescens arelate Banks
21. Tergum 1 and anterior part of tergum 2 largely ferruginous; free margin of the clypeal process rounded . . . . . **wyomingensis** Scullen
Black with creamy white or yellow markings only 22
22. Markings yellow. 23
Markings creamy white 25

23. Band on tergum 2 broader than on other terga; clypeal process emarginate (Eastern States, rarely west to North and South Dakota, Nebraska, and Kansas) . . . . . **atramontensis** Banks
Bands on terga 2 to 5 subequal in width 24

24. Apex of clypeal process rounded (California and bordering states).
aequalis aequalis Provancher
Apex of clypeal process somewhat truncate and emarginate (California and bordering areas) . . . . . **varians** Mickel

25. Apical end of the clypeal process acute or rounded, not emarginate (Idaho, adjoining areas, and mountains of central New Mexico).
aequalis idahoensis Scullen
Apical end of the clypeal process slightly emarginate 26

26. Apical denticle on the mandible the larger; lateral apices of the clypeal process not extended (Rocky Mountains, west to eastern Washington, east to North Dakota, north to Alberta, and south to northern Texas).
calochorti Rohwer
Medial denticle on the mandible the larger; lateral apices of the clypeal process extended to form a distinct denticle (southern California).
macswaini Scullen

27. Clypeal process sides distinctly converging to a smaller apex 28
Clypeal process sides subparallel 31

28. Markings showing considerable ferruginous or amber (eastern slope of the Rocky Mountains and adjoining areas) . . . . . **vicina** Cresson
Markings black and yellow or cream, no ferruginous or amber 29

29. Markings black and white; apex of clypeal process rounded.
aequalis bolingeri Scullen
Markings black and creamy yellow; apex of clypeal process truncate . . 30

30. Pygidium sides subparallel (Central and Northeastern States).
astarte Banks
Pygidium sides converging to a narrow apex . . **clypeata dakotensis** Banks

31. Bands on terga 2 to 5 broad and not emarginate. **morata** Cresson (in part)
Bands on terga 2 to 5 not all broad, some narrow or emarginate 32

32. Bands on terga 2 to 5 subequal in width; tergum 1 with considerable fulvous.
nebrascensis H. S. Smith
Band on tergum 2 broader than those on terga 3 to 5 33

33. Markings with considerable amber or shades of brown.
morata Cresson (in part)
Markings black and yellow, no amber or brown 34

34. Band on tergum 2 deeply emarginate (Eastern States, rarely in the Central States) . . . . . **clypeata prominens** Banks
Band on tergum 2 with little or no emargination 35

35. Bands on terga 3 to 5 narrow but unbroken and broad laterally; band on tergum 2 sometimes slightly emarginate (Eastern States, rarely west to the Great Plains) . . . . . **clypeata clypeata** Dahlbom
Bands on terga 3 to 5 absent or reduced to lateral spots; band on tergum 2 not emarginate (Great Plains, rare in the East) . **clypeata gnarina** Banks

36. Large species, 16 mm. or longer 37
Small species, 12 mm. or less in length 42

37. Clypeal process with a single acute apex . . . . . **verticalis** F. Smith
Clypeal process bicuspidate 38

38. Lateral apices of the clypeal process considerably prolonged giving the appearance of horns or the points of a new moon 39
Lateral apices of the clypeal process not greatly prolonged 40
39. Terga of the abdomen almost entirely yellow . . . **frontata frontata** Say
Terga of the abdomen with yellow bands much reduced.
frontata raui Rohwer
40. Distance between apices of the clypeal process very much less than one-third the distance between the eyes; surface of the clypeal process not lunar shaped . . . . . **mimica** Cresson
Distance between apices of the clypeal process approximately equal to or greater than one-third the distance between the eyes; surface of the clypeal process somewhat lunar shaped 41
41. Mostly black to dark amber with limited yellow.
bicornuta bicornuta Guérin
Mostly light amber and yellow . . **bicornuta fidelis** Viereck and Cockerell
42. Tergum 2 black or dark amber without a yellow band (small evanescent yellow spots may appear). 43
Tergum 2 with a yellow band 44
43. Clypeal process as long as or longer than its width at the base and with a definite overhang; tergum 1 with a creamy yellow lateral border, black medially . . . . . **azteca** Saussure
Clypeal process very low without an overhang extension (somewhat similar to that of *C. bicornuta* Guérin); tergum 1 with a broad medial yellow patch and black lateral borders . . . . . **tolteca** Saussure
44. Clypeal process with a single acute apex (mostly Northeastern States, rarely in Texas) . . . . . **nitida** Banks
Clypeal process with two or more apices 45
45. Clypeal medial lobe with a single medial acute denticle flanked by a pair of blunt denticles, all black . . . . . **melanthe** Banks
Clypeal medial lobe with a pair of yellow denticles connected by a low concave carina . . . . . **boharti** Scullen

Group I

1. Elevated process on the free surface of the central clypeal lobe distinctly separated from the anterior border 2
Clypeal process or denticles confined to or embodying the free anterior border 21
2. No red area on the abdomen or thorax 3
Distinct red area covering one or more anterior abdominal terga and possibly extending onto the propodeum of the thorax 15
3. Elevation on the surface of the clypeus a single, low, cone-shaped process with a pair of erect denticles below near the clypeal border 4
Elevation scoop shaped, truncate, or double pointed 5
4. Black with yellow markings . . . . . **vanduzeei vanduzeei** Banks
Black with cream markings . . . . . **vanduzeei eburnea** Scullen
5. Clypeal process extended so that the length is equal to or greater than the width; often inverted scoop shaped 6
Clypeal process either short and broad or otherwise modified 8
6. Apical border of clypeal process smooth and straight with rounded corners.
truncata Cameron
Apical border of clypeal process sinuate, giving the effect of three slight extensions 7

7. Markings yellow . . . . . **kennicottii kennicottii** Cresson
Markings cream . . . . . **kennicottii beali** Scullen
8. Extension near the clypeal border emarginate.
convergens Viereck and Cockerell
Process not in the form of an emarginate lobe near the clypeal border . . . 9
9. Process broad and scoop shaped, much broader than long 10
Process not scoop shaped; very low on the clypeus 12
10. Mesosternal process absent . . . . . **poculum** Scullen
Mesosternal process present 11
11. Clypeal process very broad with the apical border straight except for the extremities, which are curved downward; process cream except for black border . . . . . **chilopsidis** Viereck and Cockerell
Apical border of the clypeal process emarginate with the lateral angles extended and rounded at the apex; process black except (in some specimens) for a small yellow spot in the center . . . . . **crandalli** Scullen
12. Clypeal process with its free margin converging to a blunt point, below which are two distinct denticles . . . . . **krombeini** Scullen
Clypeal process not converging to a point 13
13. Center of face and clypeaus creamy white to white 14
Center of face and clypeus black . . . . . **echo atrata** Scullen
14. Clypeal process subequal in width to the clypeal border extension; pygidium pyriform . . . . . **acanthophila** Cockerell
Clypeal process about one-half as wide as the clypeal border extension; pygidium oval in form . . . . . **neahminax** Scullen
15. Clypeal elevation somewhat cone shaped with a single point that may be more or less rounded or blunt but not truncate 16
Clypeal elevation scoop shaped, definitely truncate or otherwise modified . 17
16. Clypeal process pointing ventrad toward the clypeal border; without erect denticles ventrad of the single elevation . . . . . **argia** Mickel
Cone-shaped process approximately vertical to the clypeal surface with two small erect black denticles ventrad of the cone-shaped process.
conifrons Mickel
17. Clypeal elevation a truncate cone 18
Clypeal elevation not a truncate cone 19
18. Silvery white markings; tegulae smooth and not elevated.
crotonella Viereck and Cockerell
Yellow markings; tegulae pitted and elevated . . . . . **irene** Banks
19. Clypeal process scoop shaped; face largely reddish yellow . . **blakei** Cresson
Clypeal process not scoop shaped; face not reddish yellow 20
20. Clypeal elevation reduced to little more than a short ridge parallel to the anterior clypeal border . . . . . **echo echo** Mickel
Clypeal elevation prominent and rounded with a deep incision on the anterior margin; single dark denticles on the lateral borders of the incision.
bridwelli Scullen
21. Distinct red area covering one or more anterior terga of the abdomen and in some cases extending on to the propodeum of the thorax 22
No red area on the abdomen or thorax 23
22. Propodeum largely black . . . . . **rufinoda rufinoda** Cresson
Propodeum red except enclosure, which is black.
rufinoda crucis Viereck and Cockrell
23. Clypeal border with a thin lobed medial process . . . . . **butleri** Scullen
Clypeal border with two widely separated hyaline points 24

24. Markings silvery white; tegula smooth, not elevated.
finitima vierecki Banks
Markings yellow; tegula elevated and pitted 25
25. Bands on terga narrow and deeply emarginate; propodeum black, immaculate; occiput black except for small yellow spots back of the compound eyes . . . . . **finitima finitima** Cresson
Yellow markings greatly extended; yellow bands on terga wide with little or no emargination; considerable yellow on the propodeum and occiput.
finitima citrina Scullen

GROUP II

1. Enclosure surface deeply ridged at 45° angle to base 2
Enclosure surface not ridged 4
2. Pygidium with sides converging uniformly to a narrow apical point; length 20 mm 3
Pygidium pyriform with sides concave on the apical half; length 14 to 15 mm.
completa Banks
3. Yellow with very limited amber markings, very little or no black.
grandis grandis Banks
Black with yellow markings . . . . . **grandis percna** Scullen
4. Abdomen black with one complete, wide ivory band on second tergum.
fumipennis Say
Abdomen largely yellow, light amber, or with light bands on more than one tergum 5
5. Posterior half of abdomen (from center of third tergum) brownish yellow; thorax black except for broken band on pronotum and metanotum . . 6
Thorax largely black or amber yellow; yellow bands on all terga or abdomen all yellow 7
6. First and second abdominal segments black . . **dilatata dilatata** Spinola
First abdominal segment reddish, second tergum with a limited amber yellow patch and red shading . . . . . **dilatata chisosensis** Scullen
7. Black with yellow markings, little or no amber.
californica californica Cresson
Head and thorax light amber marked with yellow; abdomen largely yellow or with some light amber . . . . . **californica arno** Banks

GROUP III

1. Clypeal process broad and lunar or crescent shaped with the free margin subequal to the process in width 2
Clypeal process narrowing to a margin apically subequal in width to one-half the width of the process 7
2. Process with an undivided short but continuous lamella extending over nearly the entire margin of the process . . . . . **mandibularis** Patton
Lamella of process divided into two distinct oval lobes 3
3. Process equal to approximately two-thirds of the distance between the eyes 4
Process equal to about seven-eighths of the distance between the eyes . . 6
4. Amber and yellow markings . . . . . **cochisi** Scullen
Black and yellow markings 5

5. Abdomen almost entirely yellow, occasionally some black on the first tergum; prominent yellow patch on propodeum often C-shaped.
sandiegensis Scullen

Most terga deeply emarginate with black; band on tergum 2 broader than others; propodeum with little or no yellow . **compacta compacta** Cresson

6. Black with limited yellow markings; wide yellow band on distal half of tergum 2; no red or amber . . . **flavofasciata flavofasciata** H. S. Smith

Head and thorax mostly reddish amber; first tergum reddish amber; second tergum reddish amber anteriorly, often with a yellow line posteriorly; terga 4, 5, and 6 dark amber to black . **flavofasciata floridensis** Banks

7. Lamella bent at about 45° angle to plane of clypeal process.
squamulifera Mickel

Lamella slightly or not at all bent from the plane of the clypeal process . . 8

8. Lamella undivided to base, border might be slightly emarginate 9

Lamella divided to base, divisions more or less completely separated . . 10

9. Black and yellow; no reddish amber . . . . . **robertsonii robertsonii** Fox

Prothorax, scutellum, metanotum, basal two or more terga, and legs mostly reddish amber . . . . . **robertsonii emmiltosus** Scullen

10. Black and yellow . . . . . **robertsonii bifidus** Scullen

Prothorax, scutellum, metanotum, basal two terga, and legs reddish amber with traces of yellow . . . . . **robertsonii miltosus** Scullen

Group IV

1. Length 15 to 18 mm.; punctation deep and close.
macrosticta Viereck and Cockerell

Length 10 to 12 mm.; punctation fine and more widely separated 2

2. Body colors black and yellow with very little or no amber.
femurrubrum athene Banks

Body colors amber and cream with very little black or none at all.
femurrubrum femurrubrum Viereck and Cockerell

Group V

1. Clypeal elevation low and rounded without a distinct point 2

Clypeal elevation not low and rounded but sides converging to a distinct apex, which may be blunt, approximately perpendicular to the surface; lower surface of elevation smooth and concave or flat 5

2. Color markings dark red . . . . . **rufa** Scullen

Color markings yellow or cream 3

3. Subequal narrow bands on all terga . . . . . **compar compar** Cresson

Band on tergum 2 absent or reduced to small lateral patches on the posterior margin 4

4. Usually a single elongate patch and rarely a second smaller yellow spot on the propodeum; band on tergum 3 more or less emarginate on the anterior margin; small yellow spots usually on the lateral posterior angles of tergum 2 . . . . . **compar geniculata** Cameron

Markings on propodeum fused, or nearly so, to form a hook-shaped patch; wide complete band on tergum 3; somewhat smaller than the latter subspecies . . . . . **compar orestes** Banks

5. Second tergum with a band equal to or wider than that on other terga.
zelica Banks

Second tergum immaculate or with small lateral spots on the posterior margin; bands on other terga subequal 6

6. Markings all creamy white; band on third tergum, others a narrow line (Southwest desert area, New Mexico) . . . . . **insolita albida** Scullen
Markings on body yellow 7
7. Single yellow patch on the propodeum; band on tergum 3 emarginate; pygidium fuscous; hindfemora variable shades of amber (East Central States) . . . . . **insolita insolita** Cresson
A small secondary yellow spot often appearing on the propodeum; band on tergum 3 broad and showing little or no emargination; pygidium ferruginous; hindfemora black with a creamy yellow patch near the apical end (Southwest desert area, Arizona) . . . . . **insolita atrafemori** Scullen

MALES

1. Stigma very dark to black. 2
Stigma light amber 3
2. Length not over 9 mm.; complete bands on one or more terga in addition to tergum 2 . . . . . GROUP I
Length 10 to 11 mm.; complete broad band on posterior half of tergum 2; other terga with lateral markings or broken lines only, very rarely solid lines . . . . . **fumipennis** Say (of Group II)
3. Width of clypeal hair lobes greater than the distance between them and extending onto the medial clypeal lobe 4
Width of the clypeal hair lobes no greater than the distance between them and not extending onto the medial clypeal lobe 7
4. Hair lobes meet medially or nearly so; tergum 2 immaculate; posterior half of tergum 3 and all of terga 4, 5, and 6 fulvous . . . . **azteca** Saussure
Hair lobes distinctly separated medially; bands on terga 4, 5, and 6 not all broad, at least some are narrow or deeply emarginate 5
5. Medial denticle of the clypeal margin bicuspidate . . . . . GROUP IV
Medial denticle of the clypeal margin not bicuspidate 6
6. Pygidium semioval; lateral clypeal lobe heavily setose . . **tolteca** Saussure
Pygidium elongate, approximately twice as long as it is broad; lateral clypeal lobe very lightly setose . . . . . GROUP V
7. Medial lobe of clypeus less than half as wide as lateral lobe . . . GROUP III
Medial lobe of clypeus subequal to or wider than lateral lobe 8
8. Prominent cluster of bristles at the side of the pygidium 9
Bristles adjacent to pygidium sparse 12
9. Bands on all terga narrowly interrupted along midline 10
Not all bands on terga narrowly interrupted along midline 11
10. Pygidium broad, width subequal to length; pubescence normal. **verticalis** F. Smith
Pygidium much longer than broad; pubescence very long on most body parts; pubescence on venter very prominent . . . . . **mimica** Cresson
11. Background color largely black . . . . . **bicornuta bicornuta** Guérin
Background color largely ferruginous (Southwest desert area). **bicornuta fidelis** Viereck and Cockerell
12. Basal width of second tergum subequal to one-third the greatest width of the segment . . . . . GROUP II
Basal width of second tergum subequal to or greater in width than one-half of the greatest width of the segment 13
13. More or less ferruginous or amber replacing the darker color, especially along the margins of the dorsal abdominal markings 14
Black with yellow, cream-colored, or white markings only 16

14. Pygidium with sides diverging slightly apically and convex on the apical end . . . . . **morata** Cresson
(also *vicina* Cresson)[4]

Pygidium with sides converging slightly and the apical end slightly concave 15

15. Bands of yellow on the terga with little or no emargination.
frontata frontata Say

Bands on the terga deeply emarginate anteriorly . . **frontata raui** Rohwer

16. Band on tergum 2 distinctly wider than the bands on other terga . . 17

Bands on all terga subequal 19

17. Small species, approximately 8 mm. in length . . . . . **nitida** Banks

Medium in length, 10 to 12 mm. 18

18. Band on tergum 2 deeply emarginate . . . . **clypeata prominens** Banks
(probably also *halone* Banks)

Band on tergum 2 not emarginate or, if so, very little.
clypeata clypeata Dahlbom
(probably also *clypeata gnarina* Banks, *dakotensis* Banks, *posticata* Banks,[5] *atramontensis* Banks, *rhois* Rohwer[5])

19. Small species about 9 mm. in length; clypeal denticles reduced to two (Northeastern United States) . . . . . **astarte** Banks

Medium to large species, 10 mm. or longer; three more or less distinct clypeal denticles 20

20. Denticles on the clypeal margin separated by a distance subequal to one-fifth the width of the medial lobe; a distinct transverse ridge just above the denticles (Eastern States) . . . . . **deserta** Say

Denticles on the clypeal margin in approximate conjunction; no transverse ridge on the surface of the medial lobe 21

21. Markings yellow 22

Markings white to cream 26

22. Lateral clypeal denticle prominent; the medial clypeal denticle greatly reduced or absent 23

Three clypeal denticles subequal 24

23. Medial clypeal lobe with a distinct transverse swelling about the level of the anterior tentorial pits (Central States south to Texas).
occipitomaculata Packard

Medial clypeal lobe without a distinct transverse swelling but generally convex . . . . . **nigrescens arelate** Banks

24. Length about 10 mm.; denticles on the clypeal border very indistinct (California and adjoining states) . . . . . **nigrescens munda** Mickel
(probably also *aequalis aequalis* Provancher, *varians* Mickel, *dentifrons* Cresson)

Length about 13 mm.; denticles on clypeal border more distinct 25

25. Seventh tergum with yellow to the sides of the pygidium (West Coast States) . . . . . **tepaneca** Saussure

Seventh tergum immaculate (Central Plains States) . . . . . **sexta** Say
(also *posticata* Banks, *rhois* Rohwer)

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[4] The males of *morata* Cresson and *vicina* Cresson so far are inseparable except by association with the females.

[5] The type of *posticata* Banks runs to couplet 18b. It is a unique that may be *sexta* Say with an abnormally wide band on tergum 2. The type of *rhois* Rohwer, which also runs to this couplet, could be the male of *clypeata gnarina* Banks, but the type locality is out of the known range of that species.

26. Length 14 to 15 mm. (North Central States) . . . . . **stigmosalis** Banks
Length 9 to 10 mm. 27

27. Propodeum immaculate (Northern States from coast to coast).
nigrescens nigrescens F. Smith
Propodeum with large white patches 28

28. Enclosure smooth (eastern slope of the Rocky Mountains).
calochorti Rohwer
Enclosure more or less coarsely ridged (southern California).
macswaini Scullen

GROUP I

1. Showing shades of ferruginous or red on the first abdominal tergum and bordering areas 2
Colors black with yellow, white, or cream markings only, no ferruginous or red markings 6

2. Markings creamy white or white 3
Markings yellow 5

3. Terga 2, 3, and 4 with broad bands of creamy white, in some specimens the fourth showing slight emargination; punctation sparse (known only from southern California and southern Arizona) . . . **bridwelli** Scullen
Wide bands on terga 2 and 3 only, or all bands subequal and of medium width; punctation crowded or average 4

4. Bands on terga 2 and 3 broad medially but narrowing laterally, bands on 4 and 5 narrow; punctation medium (known only from southwestern Arizona and southern Texas) . . . . . **crotonella** Viereck and Cockerell
Bands on terga 2 to 6 subequal and of medium width; punctation crowded (general over western arid sections but more common in the Southwest).
conifrons Mickel

5. Band on tergum 2 with a deep V-shaped emargination, bands on terga 3 to 6 broad but deeply emarginate and often completely divided (extreme Southeastern States) . . . . . **blakei** Cresson
Band on tergum 2 broad and with little or no emargination, bands on terga 3 to 6 of medium width with broad and moderately deep emarginations (recorded from most states except the New England States, the Great Lake Area and the extreme Southeast) . . . **rufinoda rufinoda** Cresson (also *echo echo* Mickel;[6] *argia* Mickel and *irene* Banks, when recognized, probably will run to this couplet also)

6. Markings on the abdomen creamy 7
Markings on the abdomen yellow 12

7. Propodeum with medium patches of creamy white; usually two small spots near the apex of the enclosure; first tergum cream except for a black patch at the base (southern Arizona, New Mexico, and Texas).
truncata Cameron
Propodeum and enclosure immaculate; tergum 1 either immaculate or with only a small cream patch on the dorsum 8

[6] The males of *rufinoda rufinoda* Cresson and *echo echo* Mickel so far are indistinguishable except as they are associated with the females. Some specimens of males taken at the same time and place as some females of *echo echo* Mickel are more cream than the males usually accepted as the males of *rufinoda rufinoda* Cresson. These forms with lighter markings may prove to be the males of *echo echo* Mickel.

8. Band on tergum 3 missing, a broken line, or divided into three sections; spot on first tergum very small or absent; lateral lobes of the clypeus black . 9
Band on tergum 3 unbroken but emarginate 10

9. Band on tergum 3 divided at two points to form three parts subequal in length (in some specimens these divisions are represented by indentations only); entire face black except for two large frontal eye patches; medial denticle on the clypeal margin more prominent than the others (west of the Rocky Mountains from British Columbia to Texas).
convergens Viereck and Cockerell (in part)
Band on tergum 3 usually a broken or evanescent line; lateral lobes and lower margin of the medial lobe of the clypeus black; frontal area black with a small evanescent spot of cream (Southwestern States).
kennicottii beali Scullen

10. Tergum 1 immaculate; apex of median lobe and lateral lobes of clypeus black; face otherwise creamy yellow . . . . . **cleome** Rohwer
Tergum 1 with a distinct patch 11

11. Clypeal denticles clearly defined; tegulae showing a tendency to be elevated and inflated; light apical end of the third femora demarked somewhat obliquely (Southwestern States) . . . . . **finitima viereckі** Banks
Clypeal denticles less elevated and distinct; tegulae not elevated or inflated; light apical end of the third femora demarked nearly at right angle to the femur 12

12. Scutellum immaculate; pygidium nearly as broad as it is long.
crandelli Scullen
Scutellum with two cream patches; pygidium about one and one-half as long as it is broad . . . . . **acanthophila** Cockerell
(also *carrizoensis* Banks, *cockerelli* Viereck)

13. Tegulae elevated 14
Tegulae not elevated 16

14. Tegulae smooth; enclosure smooth except for a medial groove and a limited number of deep pits along the lateral margins (southern Arizona).
krombeini Scullen
Tegulae pitted; enclosure heavily regose or ridged subparallel to the anterior border 15

15. Band on tergum 3 deeply emarginate; no yellow marks on the genae or occiput (more common in the Eastern States but ranges into California).
finitima finitima Cresson[1]
Broad band on terga 2, 3, and often 4 with little or no emargination; commonly large yellow patches back of the eyes and a broken band on the occiput (southern and central California) . . . **finitima citrina** Scullen

16. Band on tergum 3 divided at two points to form three parts subequal in length (in some specimens these divisions are represented by indentations only); entire face black except for two large frontal eye patches; medial denticle on the clypeal margin more prominent than the others (west of the Rocky Mountains from British Columbia to Texas).
convergens Viereck and Cockerell (in part)
Band on tergum 3 reduced to a broken evanescent line or completely eliminated medially; lateral lobes of the clypeus black; apical border of the medial lobe of the clypeus black; frons black (recorded from most of the Eastern States and Southwest) . . . . **kennicottii kennicottii** Cresson

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[1] *C. arizonella* Banks appears to be a form between *C. f. finitima* Cresson and *C. f. citrina* Scullen.

GROUP II

1. Tergum 2 black or with more or less ferruginous 2
   Tergum 2 all yellow or with a broad yellow band 3
2. Terga 1 and 2 black, basal half of tergum 3 black; posterior half of tergum 3 and remaining posterior terga brownish yellow (Arizona, New Mexico, and southern Texas) . . . . . **dilatata dilatata** Spinola
   Black of basal abdominal segments more or less replaced with red (Big Bend National Park and Davis Mts. in Texas, southern New Mexico, and southern Arizona) . . . . . **dilatata chisosensis** Scullen
3. All terga of the abdomen yellow or very light fulvous except for a trace of emargination at the base 4
   Bands on terga 3 to 6 deeply emarginate anteriorly in middle 6
4. Thorax black to dark fuscous background; first abdominal segment may show more or less red . . . . . **californica californica** Cresson (in part)
   Thoracic background fulvous 5
5. About 10 mm. in length; enclosure lightly ridged (southern California and adjoining areas . . . . . **californica arno** Banks
   About 14 mm. in length; enclosure relatively smooth but with a few pits in the lateral angles (southern California and adjoining areas).
   grandis grandis Banks
6. Length about 10 mm.; legs amber and yellow (this species shows great variation in amounts and shades of yellow and red throughout its range west of the Rocky Mountains from British Columbia to Texas).
   californica californica Cresson (in part)
   Length about 12 to 15 mm.; legs black and yellow; emarginations on terga usually narrow but deep, that on tergum 2 with a tendency to be enclosed by yellow (California and southwestern Oregon) . . . **completa** Banks

GROUP III

1. Broad bands with little or no emargination on terga 3 to 6 2
   Bands on terga 3 to 6 either greatly reduced or with deep emarginations . 3
2. Background black or dark fuscous (southern California).
   sandiegensis Scullen
   Backgound ferruginous (southern Arizona and adjoining areas).
   cochisi Scullen
3. Black with yellow and/or fulvous markings, no red or ferruginous . . . 5
   Black with red and/or ferruginous markings (Florida and adjoining areas) . 4
4. Marginal extension of the clypeus about as wide as half the length of the epistomal suture; mandibular denticles strong; enclosure smooth.
   flavofasciata floridensis Banks
   Marginal extension of the clypeus about equal in width to the length of the epistomal suture; mandibular denticles small; enclosure ridged.
   rufopicta F. Smith[8]
5. Lower part of the clypeus showing considerable black and the yellow area of the medial lobe tapering apically to an acute point; metanotum yellow (common through the Eastern States from southern Minnesota, southern Wisconsin, southern Michigan, and New England south to the Gulf of Mexico and west to Utah and the Southwest) . **compacta compacta** Cresson

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[8] Field observations may prove *C. rufopicta* F. Smith to be the male of *C. robertsonii emmiltosus* Scullen or *C. robertsonii miltosus* Scullen.

Face yellow with little or no black margin on the clypeus; yellow of face does not end apically in an acute point; metanotum immaculate or with very little yellow 6

6. Bands on terga 3 to 6 reduced to an evanescent line or to small lateral patches (scattering through the East from Kansas and Nebraska to the Atlantic States) . . . . . **flavofasciata flavofasciata** H. S. Smith

Bands on terga solid but relatively narrow lines (distribution similar to the latter species) . . . . . **robertsonii robertsonii** Fox

(probably *robertsonii bifidus* Scullen, *mandibularis* Patton)

Group IV

1. Length about 15 mm.; markings dark fuscous, ferruginous, and yellow. **macrosticta** Viereck and Cockerell

Length about 11 mm.; markings black and creamy white. **femurrubrum** Viereck and Cockerell

Group V

1. Markings black with rufous (Florida) . . . . . **rufa** Scullen

Markings black and yellow or creamy white 2

2. Tergum 2 immaculate or with small lateral spots only 3

Tergum 2 with a solid but narrow band (general over Eastern States from Nebraska, Kansas, and Texas to the Atlantic Coast). **compar compar** Cresson

3. Without a mesosternal process or ridge (southern Arizona). **compar orestes** Banks

(Probably *zelica* Banks)

With a mesosternal process or ridge (sometimes very slight) 4

4. Mesosternal process broad and considerably extended; markings yellow (only one recorded from southern Arizona). **compar geniculata** Cameron

Mesosternal process reduced to a slight ridge 5

5. Markings yellow (Eastern States from the Missouri River and Texas to the Atlantic States) . . . . . **insolita insolita** Cresson

Markings creamy white (southern Arizona, New Mexico, and southwestern Texas) . . . . . **insolita albida** Scullen

(Additional male belonging to Group V but not yet known: *insolita atrafemori* Scullen)

Group I

This group[9] is distinguished by the following characters: (1) small size, (2) very dark stigma, (3) punctation usually very crowded, (4) anterior abdominal segments and propodeum often more or less reddish, (5) mandibles of female with two denticles, (6) mesosternal tubercle on the female, (7) small and widely separated hair lobes on the male, (8) apical segment of the antennae normal in the male.

[9] This group is the one Banks (1947, p. 26) calls *Apiraptrix* (Shestakov). Banks misspelled this "*Apiratrix*." In a personal letter, de Beaumont informs the present writer that this group is not *Apiraptrix* (Shestakov). The latter is related to *C. rybyensis* (Linnaeus) Schletterer.

1. *Cerceris acanthophila* Cockerell

FIGURES 1, 108a,b,c

Cerceris acanthophila Cockerell, 1897, p. 135.—Ashmead, 1899, p. 296.—Viereck and Cockerell, 1904, p. 138.—Viereck, 1906b, p. 234.—Banks, 1947, p. 30.—Scullen, 1951, p. 1004; 1960, p. 75.

Cerceris minax Mickel, 1917a, p. 339.—Banks, 1947, p. 34.—Scullen, 1951, p. 1009.

Cerceris huachuca Banks, 1947, p. 29.—Scullen, 1951, p. 1008.

FEMALE.—Length 8 to 9 mm. Black with yellow to creamy-white markings, normally pitted, clothed with short silvery hairs.

Head slightly wider than the thorax; front creamy white below antennae except apical borders, which are dark; vertex, occiput, and genae black except for small spots back of compound eyes, which are creamy white; clypeal border slightly sinuate; clypeal elevation close to the anterior border, very short and subequal in width to the extension of the clypeal border, slightly emarginate; mandibles with two separated, centrally located subequal denticles; yellow at the base becoming dark amber apically; antennae normal in form, creamy-white patch on the scape, pedicel dark amber, flagellum light amber below, dark amber above.

Thorax black except for two elongate patches on the pronotum, the metanotum, and the tegulae, which are creamy white; propodeum immaculate, heavily and closely pitted except for the enclosure, which is moderately rugose; mesosternal tubercle small and black; legs black except for apical ends of femora, fore- and midtibiae, fore- and midtarsi, basal two-thirds of the hindtibiae, and basal third of the hindtarsi, which are light yellow; wings subhyaline, stigma medium dark (lighter than is usual in the group).

Abdomen: terga 1 to 5 black with creamy-white bands deeply emarginate on 2 to 5; venter black except lateral yellow spots on sternites 3 and 4 (immaculate in some specimens); pygidium pyriform, widest near the base, narrowed apically with a cluster of small bristles on each side inserted on the apical sternite.

MALE.—Length 7 mm. Black with creamy-white markings; punctation and pubescence average.

Head slightly wider than the thorax; black except for the entire face, basal part of mandibles, and the scape, all of which are creamy white; peduncle and flagellum ferruginous above and light fulvous below; three clypeal border denticles distinct but not prominent; hair lobes narrow; mandibles smooth with a slight medial elevation.

Thorax black except for a divided band on the pronotum, the scutellum, the metanotum, a small spot on the pleuron, and a patch on the tegulae, all of which are creamy white; mesosternal tubercle

absent; legs black basally to the apical ends of all femora; fore- and midlegs are creamy white apically except the tarsi, which become light fulvous; the hindlegs are creamy white on the apical end of the femora and basal half of the tibiae, beyond which they are largely black; wings subhyaline but slightly clouded apically.

Abdomen black except for a small patch on tergum 1, broad band on tergum 2, narrower and emarginate bands on terga 3, 4, and 5 and a small spot on tergum 6, all of which are creamy white; venter immaculate; pygidium with sides slightly convex, ends subequal in width and broadly rounded.

Many of the specimens show the markings more yellow than white. The lighter forms are more common in the Pacific Northwest and in the southwestern desert area. It is possible subspecies should be recognized. The extent of the light markings varies. In some specimens spots appear below the wing attachments and on the mesosternal tubercles.

The clypeal process easily distinguishes the female of *acanthophila* Cockerell from closely related species such as *finitima* Cresson.

TYPES.—A male of *C. acanthophila* Cockerell is in the Philadelphia Academy of Natural History, ANSP type no. 10038, from Deming, N. Mex. This is considered the lectotype designated by Cresson in 1928. Another male, apparently from the same series, is in the National Museum, Washington, D.C., type no. 3409. A second specimen with a blue ANSP paratype label 10038 is also in the Philadelphia Academy of Natural History.

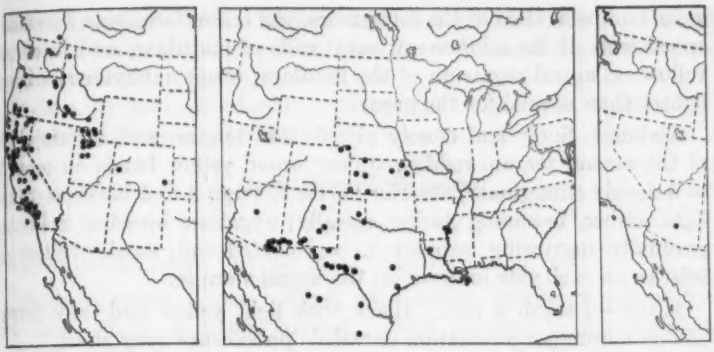
The holotype female and allotype male of *C. minax* Mickel from Sacramento, Calif., are at the University of Nebraska. Three paratype females from Auburn, Calif., are also at the University of Nebraska.

The holotype male of *C. huachuca* Banks from Patagonia, Ariz., is in the Museum of Comparative Zoology, Harvard University, type no. 27636.

DISTRIBUTION.—West of the Continental Divide from British Columbia into Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Achillea* (Idaho, Oregon), *Achillea millefolium* (Oregon), *Asclepias mexicana* (Oregon), *Boerhaavia erecta* (New Mexico), *Daucus carota* (California, Idaho, Oregon), *Eriogonum* (California, Idaho, Oregon), *Eriogonum fasciculatum* var. *polifolium* (California), *Foeniculum vulgare* (California), *Harmizonia fasciculatum* (California), *Helianthus* (Idaho), *Melilotus* (California), *Melilotus alba* (Oregon), *Pastinaca sativa* (Utah), *Rhamnus* (California), *Salsola kali tenuifolia* (Utah), *Solidago* (New Mexico, Oregon), *Tamerix* (Utah), *Zizyphus lycioides* (New Mexico).



FIGURES 1–3.—Localities of: 1, *C. acanthophila* Cockerell; 2, *C. argia* Mickel (females only); 3, *C. arizonella* Banks.

2. *Cerceris argia* Mickel

FIGURES 2, 109a,b,c

Cerceris argia Mickel, 1916, p. 412; 1917b, p. 453.—Scullen, 1951, p. 1005.

FEMALE.—Length 9 to 10 mm. Black with yellow markings except the propodeum and the basal end of the abdomen, which are reddish amber; more closely and finely pitted than most species; clothed with short silvery hairs.

Head about one-sixth wider than the thorax, normally pitted, clothed with very short silvery hairs; front yellow below the antennae except for the anterior third of the clypeus, which is amber; occiput immaculate, black in the type (many specimens show two converging, elongate yellow patches); genae black with a yellow spot back of each compound eye; clypeal border irregularly sinuate; clypeal process low with a single rounded end pointing ventrad, yellow with the free border amber; mandibles with two separated, centrally located subequal denticles, yellow at the base, amber apically; antennae normal in form, yellow area on scape, peduncle amber, flagellum light amber below, dark amber above.

Thorax closely pitted except on the scutellum, the metanotum, and the enclosure, clothed with short silvery hairs, black except for two elongate patches on the pronotum, two oval patches on the scutellum, the metanotum, a patch on the pleura, and the tegulae, all of which are light yellow; tegulae elevated and lightly pitted; the propodeum is reddish amber except for the enclosure, which is black; enclosure is smooth except for a mesal groove and lateral ridges, which are set at about a 45° angle to the mesal groove; mesosternal tubercles small and black; legs largely light amber except for yellow

areas on apical ends of the forefemora, the entire foretibiae, foretarsi, apical ends of the midfemora, basal ends of midtibiae, and traces of yellow on apical segments of the hindlegs; wings subhyaline, stigma lighter than normal for the group.

Abdomen finely and closely pitted; first tergum and anterior half of the second tergum reddish amber; broad yellow bands on terga 2 to 5 deeply emarginate; anterior halves of terga 3 to 5 black; sternum light amber, becoming darker apically; pygidium broad at the base, gradually narrowing apically to a rounded end; small clusters of bristles on each side inserted on the apical sternite.

MALE.—Length 8 mm. Black with light yellow and dark ferruginous markings; punctation crowded; pubescence very short.

Head subequal in width to the thorax; black except for the large frontal eye patches, most of the medial lobe of the clypeus, and the frons, all of which are light yellow; lateral lobes of the clypeus and the free border of the medial lobe of the clypeus are black; medial clypeal lobe with a small medial denticle and two less distinct lateral denticles; hair lobes extending onto the medial lobe; mandibles without denticles; antennae normal in form with a small yellow patch on the scape, the peduncle dark and the flagellum fulvous below becoming darker above.

Thorax black except for a divided band on the pronotum, most of the tegulae, and a small spot on the pleuron below the wing, all of which are light yellow; tegulae slightly elevated and with scattered pits; enclosure deeply and coarsely pitted; mesosternal tubercles absent; legs black except the apical ends of all femora and the more apical segments, which are yellow infused with darker areas; the third trochanter and the adjoining end of the femur dark ferruginous; wings subhyaline, somewhat clouded at the apex and the stigma dark.

Abdomen black except the first segment and the anterior margin of the second sternite, which are dark ferruginous, and a broad convex band on tergum 2, narrower emarginate bands on terga 3, 4, and 5, and a small patch on tergum 6, all of which are light yellow; venter all black except sternite 1 and the anterior border of sternite 2, which are dark ferruginous; pygidium deeply pitted, strongly convex laterally, proximal end rounded and distal end truncate.

A study of many specimens from the same area shows the elongate yellow spots on the vertex are common and vary in size. The tegulae may also vary in elevation and smoothness. The female of *C. argia* Mickel resembles others of the *rufinoda* group but is distinguished easily by the clypeal process.

TYPE.—The type female of *C. argia* Mickel is at the University of Nebraska.

DISTRIBUTION.—From Kansas and eastern Colorado southwest through Texas, Louisiana, New Mexico, and Arizona into Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Euphorbia marginata* (Texas), *Lepidium* (Arizona), *Solidago* sp. (Nebraska).

3. *Cerceris arizonella* Banks

FIGURE 3

Cerceris arizonella Banks, 1947, pp. 32–33.—Scullen, 1951, p. 1005.

MALE.—Length 4 mm. Black with yellow markings except for the face, which is cream colored. Band on tergum 2 somewhat wider than the others.

This species is known only from the type, which is close to *finitima* Cresson. It may prove to be an abnormally small specimen of that species. Until more positive characters for separating males are found, the author will let it remain a valid species.

TYPE.—The type male, from Tempe, Ariz., is at the Museum of Comparative Zoology, no. 23538.

PREY RECORD.—None.

PLANT RECORD.—None.

4. *Cerceris blakei* Cresson

FIGURES 4, 110a,b,c

Cerceris blakei Cresson, 1865, p. 121.—Packard, 1866, p. 61.—Cresson, 1887, p. 282.—Dalla Torre, 1897, p. 454.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Banks, 1912a, p. 26.—Scullen, 1951, p. 1005.—Krombein, 1952c, p. 336; 1954b, p. 235; 1955, p. 234.—Scullen, 1961, p. 45.[10]

Cerceris elegans F. Smith, 1856, p. 467.—Cresson, 1865, p. 131.—Packard, 1866, p. 64.—Cresson, 1887, p. 282.—Dalla Torre, 1890, p. 200.—Ashmead, 1899, p. 295.

Cerceris blackii [sic] Schletterer, 1887, p. 487.

FEMALE.—Length 9 to 10 mm. Black with reddish-amber markings, the amber markings becoming yellow centrally in certain areas; deeply and closely pitted; clothed with very short silvery hairs.

Head about one-third wider than the thorax, black except sides of face, front, dorsal surface of the clypeal process, and small spots back of the compound eyes, all of which are yellow, and the clypeus below the process, which is amber; clypeal border sinuate, depressed medially; clypeal process scoop shaped with lateral sides subparallel and apical border smooth and uniformally curved; mandibles with two

[10] *Cerceris elegantissima* Schletterer, 1887, was a new name proposed for *Eucerceris elegans* Cresson and not for *C. elegans* F. Smith as stated by Scullen (1961, p. 45).

separated, centrally located denticles, the apical one much the larger; antennae normal in form, amber except the scape, which is yellow.

Thorax black except two patches on the pronotum, two small spots on the propodeum, two small spots on the scutellum, and the tegulae, all of which are yellow, and the metanotum, which is yellow to amber; tegulae elevated and lightly pitted; enclosure smooth except for a longitudinal groove and pitted lateral borders; mesosternal tubercle small and black; legs yellow except for basal portions of femora, coxae, and trochanters, which are amber; wings uniformally clouded except for the stigma, which is dark amber.

Abdomen: tergum 1 light amber; tergum 2 yellow, deeply emarginate with light amber; terga 3, 4, and 5 with anterior emarginations amber and deep, dividing, or almost dividing, the yellow into lateral triangular areas; venter light amber basally becoming dark apically; pygidium oval with the apical end truncate and the basal end rounded.

The extent of the yellow markings varies. Yellow spots on the head and thorax may disappear completely in some specimens. Yellow and amber areas on the abdomen show much variation in their width and emargination.

MALE.—Length 8 mm. General coloration, punctation, and pubescence similar to the female.

Head about one-third wider than the thorax; face yellow at the sides and below the antennae, remainder of head black; three amber denticles on the clypeal border, the medial one more broad and rounded than the lateral ones.

Thorax black except for two patches on the pronotum, two spots on the scutellum, narrow band on the metanotum, and the tegulae, all of which are yellow; tegulae elevated and lightly pitted; enclosure deeply pitted to rugose; mesosternal tubercle absent; legs yellow except for basal two-thirds of femora, trochanters, and coxae, which are amber to black; antennae normal; wings uniformally clouded except for the stigma, which is dark amber.

Abdomen: tergum 1 black with a broad divided amber band; terga 2 to 6 light amber to yellow, deeply emarginate anteriorly with black; venter dark amber, immaculate; pygidium slightly oval, truncate apically, rounded basally.

The males are most apt to be confused with the males of *finitima finitima* Cresson and *kennicottii kennicottii* Cresson. *C. finitima finitima* Cresson lacks the amber shading. *C. kennicottii kennicottii* Cresson has the tegulae unelevated, smooth, and is black and yellow, without amber.

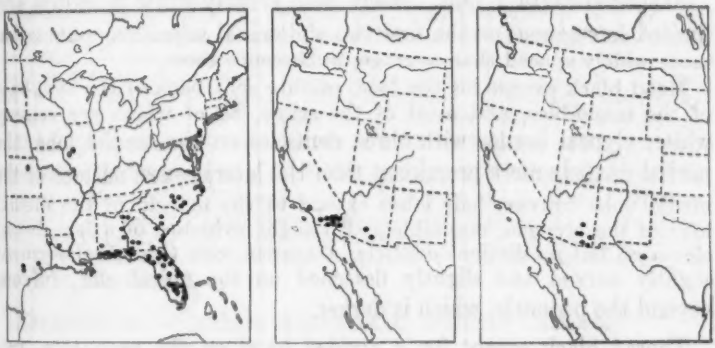
TYPE.—The type female, from southwest Georgia (Charles A. Blake), is at the Philadelphia Academy of Natural Sciences, no. 1947.

DISTRIBUTION.—Mostly in the Southeastern States from eastern Texas to North Carolina and isolated records as follows:

ILLINOIS: Havana, Aug. 30, 1917; Meredosia, Aug. 22, 1898 (F.M.McE.) Aug. 1899. KANSAS: Riley Co., July 17 (Popenoe). NEW JERSEY: Camden Co. (Wm. J. Fox); Pemberton, Sept. 1, 1907.

PREY RECORDS.—*Derelomus basalis* LeConte, *Limnobaris confusa* Bocheman, *Anthonomus sexguttatus* Dietz and *Hyperodes* sp. (all weevils). *C. blakei* Cresson seems to prefer the first species. Less commonly taken were the chrysomelid *Graphops floridana* Blake and the tenebrionid *Blakstinus interruptis* (Say). All records are by Krombein (1963) from Florida.

PLANT RECORDS.—*Aldenella tenuifolia* (Florida, for nectar?), *Asclepias* (North Carolina), *Bidens bipinnata* (North Carolina), *Borieria* (Florida), *Cyanotis* (Alabama), *Erigeron quercifolius* (Florida), *Eriogonum tomentosum* (Florida), *Koellia* (North Carolina), lemon balm (Florida), *Pinus serotina* (North Carolina), *Polygonum hyropiperoides* (Florida), *Quercus virginiana* (North Carolina), *Sabal etonia* (Florida, for prey), *Satureia hortensis* (Louisiana).



FIGURES 4–6.—Localities of: 4, *C. blakei* Cresson; 5, *C. bridwelli* Scullen; 6, *C. butleri* Scullen.

5. *Cerceris bridwelli*, new species

FIGURES 5, 111a,b,c

FEMALE.—Length 8 mm. Black with creamy-yellow and amber markings; normally pitted, clothed with short silvery hairs.

Head about 50% wider than the thorax; black except sides of face, compressed strip between the antennae, the clypeus, two round spots behind the compound eyes, proximal half of the mandibles, and the scape of the antennae, all of which are creamy yellow; clypeal border extended and sinuate; clypeal process prominent, rounded, and

deeply depressed on the anterior side with the free border curved and ending on each side as a dark amber apex; mandibles with two separated denticles, the apical one very much the larger; antennae normal in form, amber except the scape, which is creamy yellow.

Thorax black except band on the pronotum, scutellum, metanotum, the tegulae, and two patches on the pleura, which are creamy yellow; tegulae smooth and not elevated; propodeum largely amber with a yellow patch on each side; enclosure black, lightly ridged at a 45° angle to the medial row of deep pits; mesosternal tubercle prominent and marked with creamy yellow; legs amber basally, changing to creamy yellow midway on the femora; wings subhyaline except the stigma, which is dark amber.

Abdomen more sparsely but deeply pitted than the head and thorax; tergum 1 light amber with a partly divided yellow patch; terga 2 to 5 creamy yellow with a dark amber emargination on the anterior sides; pygidium oval with both ends rounded but narrowing apically; venter amber except two small spots on sternite 2 and narrow bands on sternites 3 and 4, which are creamy yellow.

MALE.—Length 7 mm. Black with creamy-white markings and limited ferruginous on the first two abdominal segments; punctation more widely spaced than average; pubescence short.

Head black except for the face, minute spot back of the eye, base of the mandibles, and most of the scape, all of which are creamy white; clypeal border with three denticles on the medial lobe, the medial denticle more prominent than the lateral ones; surface of the medial lobe convex; hair lobes extend to the margin of the medial lobe of the clypeus; mandibles with slight evidence of a low, broad elevation but no distinct denticle; antennae with the apical segment slightly curved and slightly flattened on the apical end, fulvous beyond the peduncle, which is darker.

Thorax black except for a divided band on the pronotum, two patches on the scutellum, the metanotum, a prominent patch on the pleuron, and the tegulae, all of which are creamy white; tegulae low and smooth; enclosure with a deeply pitted medial groove and deeply pitted lateral margins; mesosternal tubercles absent; legs dark fuscous over the basal parts and largely creamy white over the apical ends of the femora and the more apical segments; the trochanter of the midleg shows a tendency to be lighter than the adjoining leg segments; wings subhyaline, stigma very dark.

Abdomen black except the entire first segment is ferruginous and terga 2, 3, and 4 have broad bands, tergum 5 has a narrow band and tergum 6 a narrow broken line, all of which are creamy white; venter with lateral creamy-white patches on sternites 2, 3, and 4 (that on 2

very much smaller); pygidium with sides convex and the apical end slightly smaller than the basal end.

The male of *bridwelli* Scullen is very close to the male of *crotonella* Viereck and Cockerell in size, surface sculpturing, and color pattern except there are three broad bands on the terga of the former and two broad bands on the terga of the latter; however, the band on tergum 3 of the former occasionally shows a slight emargination or medial evanescent black spot.

Yellow areas on both sexes show some variation in extent and smaller spots may disappear in some specimens; band on tergum 4 may be more or less emarginate.

TYPES.—Type female and allotype male, from Imperial Co., Calif., June 1911 (J. C. Bridwell), are at the U.S. National Museum, no. 66154. Paratypes are as follows:

ARIZONA: 2♀♀, 25 mi. W. Blythe, June 1937 (J. C. Elmore); 2♂♂, 11 mi. SW. Eloy, Pinal Co., June 19, 1953 (T. R. Haig); ♀, 3♂♂, 10 mi. S. Toltec, Pinal Co., June 15, 21, 1953 (T. R. Haig); ♀, Tucson, Apr. 25, 1940 (R. H. Crandall); ♀, Yuma, May 4, 1918 (J. C. Bradley); ♀, Yuma, May 6, 1939 (M. R. Bohart). CALIFORNIA: ♀, Blythe, Riverside Co., May 8, 1947 (J. W. MacSwain, F. G. Linsley); ♀, Borego, San Diego Co., Apr. 5, 1940 (R. M. Bohart); 5♀♀, 11♂♂, Borego, San Diego Co., Apr. 25, 26, 27, 30, 1954, *Croton californicus*, *Eriogonum inflatum* (M. Wasbauer); ♂, Borego, San Diego Co., May 2, 1952 (P. D. Hurd); 4♀♀, 5♂♂, Borego Valley, San Diego Co., May 26, 1954 (F. X. Williams); ♂, Calexico, Aug. (Bequaert); ♀, Colorado Desert, May 12, 1935 (G. E. Bohart); ♀, ♂, Desert Center, May 22, 1939 (E. P. Van Dyke); ♀, Dos Palmos, Riverside Co., Apr. 3, 1934 (G. E. Bohart); 44♀♀, 57♂♂, Imperial Co., Experiment Farm, April, May, and June 1911, May and June 1912, *Baccharis glutinosa* (J. C. Bridwell); 7♀♀, 35♂♂, 4 mi. E. Mecca, Riverside Co., July 16, 21, Aug. 15, 1956, *Croton californicus* (M. Wasbauer); ♀, San Felipe Creek, San Diego Co., July 8, 1933 (G. E. Bohart); ♀, ♂, Westmorland, May 1932 (G. E. Bohart). MEXICO: Baja California: ♀, Los Animas Gulf, May 8, 1921 (E. P. Van Duzee).

DISTRIBUTION.—Southern Arizona and southern California.

PREY RECORD.—None.

PLANT RECORD.—As listed under paratypes.

6. *Cerceris butleri*, new species

FIGURES 6, 112a,b,c

FEMALE.—Length 7 mm. Black with creamy-white markings; normally pitted; clothed with very short silvery hairs.

Head slightly wider than the thorax, black except for the frontal eye patches, which are creamy white; clypeal border with a medial denticle and two lateral denticles appearing just below and laterad of the clypeal process; clypeal process very short and low with a tendency to be emarginate on some specimens, subequal in width to

the space between the antennae; mandibles with centrally located elevations barely evident; antennae normal in form, dark amber basally, becoming lighter on the flagellum.

Thorax black except for two patches on the pronotum, two small patches on the scutellum, the metanotum, patches on the tegulae, a small patch on the pleuron, all of which are creamy white; enclosure deeply and sparsely rugose; mesosternal tubercle small and black; legs black except for apical parts of fore- and midfemora aad patches on all tibiae, which are creamy white to amber; wings are subhyaline, becoming cloudy at the apex.

Abdomen: tergum 1 with a broad triangular patch; tergum 2 with a broad band curving away from the posterior border of the tergum on each side of the center, giving the band a sinuate effect; terga 3 and 4 with narrower emarginate bands; tergum 5 with an elongate patch; venter black, immaculate; pygidium oval but somewhat broader basally.

MALE.—Unknown. Possibly it is being confused with the male of *C. acanthophila* Cockerell, *C. convergens* Viereck and Cockerell, or a closely related species.

Very similar in general appearance to *C. acanthophila* Cockerell, *C. convergens* Viereck and Cockerell, *C. neahminax* Scullen, and other closely related species. The female of *C. butleri* Scullen may be recognized by the distinct clypeal process, the sinuate band on the second abdominal tergum, and the form of the pygidium as well as other characters listed in the description.

TYPES.—Type female, taken 30 miles south of Safford, Ariz., Sept. 24, 1956, on a yellow composite (G. D. Butler), is at the U.S. National Museum, no. 66155. Paratypes are as follows:

ARIZONA: ♀, Canelo, July 30, 1956 (G. D. Butler); ♀, 6 mi. E. Douglas, Cochise Co., Sept. 8, 1958, at *Heliopappus hartwegi* (P. D. Hurd); ♀, Graham Mts., 3500–4500 ft., Aug. 18, 1954 (R. M. Bohart); ♀, Portal, July 23–31, 1959 (K. V. Krombein); ♀, Portal, Chiricahua Mts., Aug. 3, 1956 (R. M. Bohart); 3♀ ♀, 2 mi. NE. Portal, July 30, Aug. 1, 3, 1959 (M. Statham); ♀, 4 mi. SE. Portal, July 28 1959 (M. Statham); ♀, Rosemont, Pima Co., Oct. 9, 1954, at *Baccharis* sp. (F. G. Werner); ♀, San Carlos, Sept. 6, 1933 (Parker); ♀, Tanque Verde, Sept. 12, 1954, at *Aplopappus* sp. (F. Werner); ♀, Tucson, Oct. 19, 1939 (R. H. Crandall); ♀, Tucson, Nov. 1, 1940 (Bryant). TEXAS: ♀, Alpine, July 8, 1952 (H. A. Scullen).

DISTRIBUTION.—Southern Arizona and the one record from Alpine, Tex.

PREY RECORD.—None.

PLANT RECORD.—As listed under paratypes.

7. *Cerceris carrizonensis* Banks

FIGURE 7

Cerceris carrizonensis Banks, 1915, 403.—Scullen, 1951, p. 1006.

MALE.—Length 6 mm. Black with creamy-white markings. Tegulae smooth and not elevated. In color and size it is close to *acanthrophila* Cockerell. Markings of the type are discolored with cyanide to some extent.

This species is known only from the type. It may prove to be a synonym, but the writer will retain it as a valid species until more positive characters are found to separate these closely related species.

TYPE.—The type male, from "Uvalde, Texas, June 18–20, 1930, Wickham," is at the Museum of Comparative Zoology, no. 13772.

8. *Cerceris chilopsidis* Viereck and Cockerell

FIGURES 8, 113a,b,c

Cerceris chilopsidis Viereck and Cockerell, 1904, p. 136.—Scullen, 1951, p. 1006.

FEMALE.—Length 10 mm. Color black with creamy-yellow markings; normally pitted; clothed with short silvery hairs.

Head about one-sixth wider than the thorax; black except for large frontal eye patches, the clypeus, basal half of the mandibles, and a small spot on the front, all of which are creamy yellow, and two round spots on the occiput, which are yellow; clypeal border slightly extended medially, sinuate; clypeal process scoop shaped but broader than long, with the free border black and curved down at the extremities; mandibles with two separate, subequal denticles dividing the mandible into three subequal parts; antennae normal in form, scape largely yellow, peduncle and apical end of scape amber, flagellum light below and dark above.

Thorax black except for two elongate patches on the pronotum, two patches on the scutellum, the metanotum, patch below the wing base, patches on the mesosternal tubercle, and the tegulae, all of which are yellow; tegulae smooth and not elevated; enclosure minutely laced, with a central groove and pitted at the borders; mesosternal tubercles prominent and largely yellow; legs dark amber basally to near the apical ends of all femora, remaining parts of legs yellow except for patches of amber on all tibiae and the medial tarsi; wings subhyaline except for a clouded area at the apex and the stigma, which is dark amber.

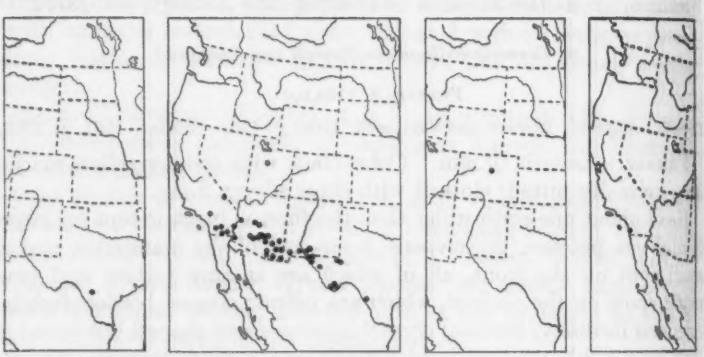
Abdomen black except for a semidivided patch on tergum 1; subequal bands on the posterior half of terga 2 to 5 broadly emarginate;

tergum 6 with venter immaculate; pygidium oval with the apical end only slightly narrower than the basal, both ends rounded.

MALE.—Unknown. Possibly it is being confused with the male of *C. convergens* Viereck and Cockerell.

C. chilopsidis Viereck and Cockerell is close to *C. convergens* Viereck and Cockerell, from which it can be separated by the form of the clypeal process and the form of the pygidium. The band on tergum 3 is never broken as it usually is in *C. convergens* Viereck and Cockerell.

TYPES.—The type female of *C. chilopsidis* Viereck and Cockerell, taken at Rincon, N. Mex. (Cockerell), July 5, at flowers of *Chilopsis saligna*, is at the Philadelphia Academy of Natural Sciences, no. 10375.



FIGURES 7–10.—Localities of: 7, *C. carrizonensis* Banks; 8, *C. chilopsidis* Viereck and Cockerell; 9, *C. cleomae* Rohwer; 10, *C. cockerelli* Viereck.

DISTRIBUTION.—Southern California, southern Arizona, southern New Mexico, southwestern Texas to Laredo, and into Mexico.

PREY RECORD.—None.

PLANT RECORD.—Alfalfa (California), *Baccharis glutinosa* (California), *Chilopsis saligna* (New Mexico), *Helianthus annuus* (Arizona, California), *Prosopis* sp. (California), *Prosopis pubescens* (locality not recorded), *Sasola pestifer* (New Mexico), *Strombocarpus pubescens* (Texas), *Tamarix gallica* (California), *Verbesina encelioides* (Arizona), *Wislizenia* sp. (Arizona).

9. *Cerceris cleomae* Rohwer

FIGURE 9

Cerceris cleomae Rohwer, 1908, p. 325.—Scullen, 1951, 1006.

MALE.—Length about 5 mm. Black with yellow and yellowish-white markings; punctation and pubescence close to the males of the *rufinoda-echo* group.

This species is known only from the type, which is in poor condition. It closely resembles the males of *C. rufinoda* Cresson and *C. echo* Mickel, which, so far, are indistinguishable from each other. It may prove to be a synonym of one of these species when better characters are found for separating these closely related males. The writer is retaining it as a valid species for the present. (See discussion under *C. rufinoda rufinoda* Cresson, p. 394.)

TYPE.—The type male of *C. cleomae* Rohwer, from Denver, Colo., July 20, 1907, on cleome (Denning), is at the U.S. National Museum, no. 25483.

10. *Cerceris cockerelli* Viereck

FIGURE 10

Cerceris cockerelli Viereck, 1902, p. 731.—Banks, 1947, p.31.—Scullen, 1951, p. 1006.

MALE.—Length 7.5 mm. Black with creamy-white markings; tegulae smooth and not elevated. It is close to *C. acanthophila* Cockerell and *C. cleomae* Rohwer in color and size. The species is known only from the two cotype males. It may prove to be the same as some closely related form. Until more positive characters are found to separate the males of these closely related species, it will be retained as a valid species.

TYPE.—The cotype males of *C. cockerelli* Viereck, from La Jolla, Calif., August 1901 (T.D.A. Cockerell), are at the Philadelphia Academy of Natural Sciences, no. 10037.

11. *Cerceris conifrons* Mickel

FIGURES 11, 114a,b,c

Cerceris conifrons Mickel, 1916, p. 410.—Mickel, 1917b, p. 450.—Banks, 1947, p. 31.—Scullen, 1951, p. 1006.
Cerceris rufinoda crucis H. S. Smith, 1908, p. 370 (in part).—Scullen, 1951, p. 1010.

FEMALE.—Length 8 to 9 mm. Black with creamy-white and yellow markings except anterior parts of abdomen and the propodeum, exclusive of the enclosure, which are reddish amber; closely and deeply pitted; clothed with very short silvery hairs.

Head one-fifth wider than the thorax; black except for the frontal eye patches, the medial clypeal lobe, patches on the lateral clypeal lobes, small patch on the lower frons, two round spots back of the compound eyes, the basal half of the mandibles, and the scape, all of which are creamy white; clypeal border with three processes, the medial one broad and somewhat rounded, the two lateral ones that are just laterad of the two curved surface denticles are smaller and more pointed; clypeus with a centrally located, low, cone-shaped elevation, below which are two black, prominent, curved denticles close to the clypeal border; mandibles with two centrally located

denticles, the apical one much the larger; antennae normal in form, scape yellow, flagellum light below and dark above.

Thorax, exclusive of the propodeum, is black except for two elongate patches on the pronotum, patches on the pleuron below the wing base, and the tegulae, all of which are creamy white; propodeum reddish amber except for the enclosure, which is black; tegulae smooth and not elevated; enclosure heavily ridged with the ridges subparallel to the metanotum and with the lateral ends curving posteriorly, mesal groove present; mesosternal tubercle prominent with a trace of yellow on the tip; forelegs and midlegs amber to near the apical ends of the femora, the remainder of the above legs yellow and amber; hindlegs light amber to the apical ends of femora, yellow changing to dark amber beyond.

Abdomen: terga 1 and 2 reddish amber; tergum 2 with a creamy-white band, terga 3 to 5 dark amber with creamy-white bands, tergum 6 dark amber, immaculate; pygidium broader basally but narrowing and truncate at both ends; venter light amber anteriorly, becoming dark posteriorly, immaculate.

MALE.—Length 6 to 7 mm. Black with creamy-white and ferruginous markings; punctation crowded; pubescence short.

Head slightly wider than the thorax; black with the exception of the face, small evanescent spots back of the eyes, base of mandibles, and most of the scape, all of which are creamy white; clypeal border with three indistinct, dentical-like extensions on the medial lobe; surface of the medial lobe of the clypeus convex; hair lobes subequal in width to the lateral lobes of the clypeus; mandibles without denticles but with a very low, broad elevation medially; antennae normal in form, scape creamy white, fulvous beyond the peduncle, which is dark.

Thorax black except for two widely separated patches on the pronotum, two spots on the scutellum, the metanotum, patch on the pleuron, and the tegulae, all of which are creamy white (in some specimens the ferruginous of the abdomen spreads more or less onto the propodeum); tegulae relatively smooth and showing little or no elevation; enclosure with heavy horizontal ridges curving laterally and a prominent medial groove; mesosternal tubercles absent; fore- and midlegs dark fuscous basally to beyond the center of the femora, beyond which they are largely creamy white; hindlegs are dark fuscous on the coxae, more or less ferruginous on the trochanters, dark fuscous over the femora except the apical end, which is creamy white, the tibiae fuscous except for a large creamy-white patch and the tarsi ferruginous; wings subhyaline, stigma black.

Abdomen black except the first tergum and basal two-thirds of the second tergum, which are ferruginous, subequal bands of creamy

white on the posterior margins of terga 2 to 6 (in some specimens an evanescent, narrow, dark line appears on tergum 2 between the yellow band and the ferruginous portion; in some specimens, also, the 6th tergum is immaculate); venter ferruginous over most of sternites 1 and 2 but dark and immaculate over the remaining sternites; pygidium with the sides convex and ends subequal in width.

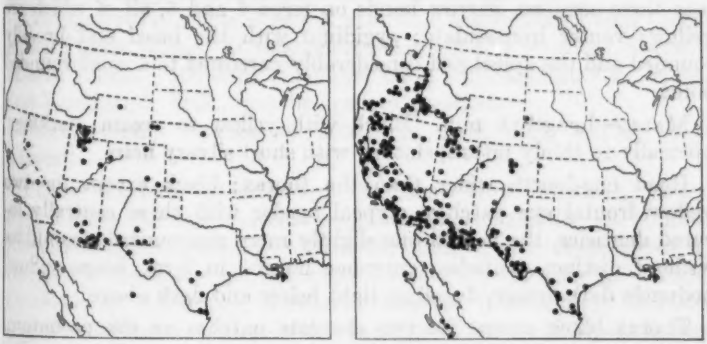
The males of *C. conifrons* Mickel may be confused with the males of other closely related forms showing ferruginous or reddish coloring on the basal segments of the abdomen. The distinctions between creamy-white and yellow markings are not always very marked.

TYPE.—The type female of *C. conifrons* Mickel is at the University of Nebraska.

DISTRIBUTION.—Except for one female taken at Medicine Hat, Alberta, on Aug. 13, 1939, by E. H. Strickland, *C. conifrons* Mickel has been taken only in the western states of Arizona, California, Colorado, Nebraska, Nevada, New Mexico, Texas, Wyoming, and Utah. It has been taken also in the state of Chihuahua, Mexico. (Due to the fact that males of this species sometimes are difficult to distinguish from closely related forms, distribution records are based only on females.)

PREY RECORD.—None.

PLANT RECORD.—*Aster* sp. (Utah), *Daucus carota* (Utah), *Chrysothamnus* sp. (New Mexico), *Helianthus* sp. (Nebraska), *Lepidium* sp. (Arizona), *Norta* sp. (Utah), *Wislizenia* sp. (Arizona).



FIGURES 11, 12.—Localities of: 11, *C. conifrons* Mickel; 12, *C. convergens* Viereck and Cockerell.

12. *Cerceris convergens* Viereck and Cockerell

FIGURES 12, 115a,b,c

Cerceris convergens Viereck and Cockerell, 1904, p. 136.—Scullen, 1942, p. 188.—Banks, 1947, p. 29.—Scullen, 1951, p. 1006.

Cerceris rinconis Viereck and Cockerell, 1904, p. 137.
Cerceris hesperina Banks, 1917, p. 115.
Cerceris pudorosa Mickel, 1917a, p. 338.
Cerceris snowi Banks, 1919, p. 84.

FEMALE.—Length 8 to 9 mm. Color black with light yellow markings; normally pitted; clothed with short silvery hairs.

Head one-fifth wider than the thorax; black except for large yellow frontal eye patches, the clypeus, and basal part of mandibles, which are light yellow; clypeal border slightly extended at the center and sinuate; clypeal process low and very short, close to clypeal border, divided into two rounded extensions, which are thin at the apex; mandibles with two subequal denticles medially located; antennae normal in form, scape yellow, peduncle dark amber, flagellum light below and dark above.

Thorax black except for two elongate patches on the pronotum, two spots on the scutellum, the metanotum, a patch on each pleuron, and the tegulae, all of which are light yellow; tegulae are smooth and not elevated; enclosure smooth except for a light medial groove and pitted borders; mesosternal tubercle prominent and tipped with yellow; legs dark amber basally to near the apical ends of all femora, the remainder of each leg being mostly yellow except for an amber patch on the apical end of the hindtibiae; wings subhyaline with a slight clouded area at the apex.

Abdomen black except for a semidivided patch on tergum 1, a broad band on tergum 2, band on tergum 3, which is usually broken into three sections, narrow bands on terga 4 and 5, all of which are yellow; venter immaculate; pygidium with the basal end broadly rounded and the apical end considerably narrowed to a small rounded point.

MALE.—Length 8 mm. Black with yellow to cream markings; normally to thinly pitted; clothed with short silvery hairs.

Head one-fourth wider than the thorax; black except for two yellow frontal eye patches; clypeal border with three centrally located denticles, the medial one slightly more pronounced; mandibles without distinct denticles; antennae normal in form, scape yellow, peduncle dark amber, flagellum light below and dark above.

Thorax black except for two elongate patches on the pronotum, the metanotum, and the tegulae, which are light yellow; tegulae smooth and not elevated; enclosure smooth except for an indistinct central groove; mesosternal tubercle absent; legs black basally to near the apical ends of all femora, remainder of all legs yellow except for black patches on apical ends of hindtibiae and darkened tarsi; wings subhyaline except for clouded area at apex.

Abdomen black except broad band on tergum 2, double broken

band on tergum 3, and narrow bands on terga 4, 5, and 6; venter black, immaculate; pygidium oval with both ends broadly rounded. In the male of *C. convergens* Viereck and Cockerell, the medial lobe of the clypeus is usually black but in many specimens more or less yellow appears on it. In both sexes it is common to find the band on tergum 3 showing slight indentations at the points where it is usually broken. In some cases even these indentations disappear.

C. convergens Viereck and Cockerell is superficially similar to several closely related species. The female can be recognized by the clypeal structures and the male by its facial colors and clypeal denticles. Both sexes usually show the breaks in the band on the third tergum of the abdomen.

TYPES.—The type female of *C. convergens* Viereck and Cockerell, from Alamogordo, N. Mex., May 13, 1902 (Viereck), is at the Philadelphia Academy of Natural Sciences, no. 10376. The type female of *C. hespirina* Banks, taken at Yakima, Wash., July 1882 (Samuel Henshaw), is at the Museum of Comparative Zoology, Harvard University, no. 10,031. No allotype male was indicated. The type female and allotype male of *C. pudorosa* Mickel, both taken at Auburn, Calif., Sept. 20, 1916 (L. Bruner), are at Nebraska State University. The type female of *C. rinconis* Viereck and Cockerell, from Rincon, N. Mex., July 5, at flowers of *Chilopses saligna*, is at the Philadelphia Academy of Natural Sciences, no. 10386. The lectotype male of *C. snowi* Banks, from Tucson, Ariz. (Snow), is at the Museum of Comparative Zoology, Harvard University, no. 13764.

DISTRIBUTION.—This is one of the most widely distributed species of the Pacific Slope. It ranges east through the Southern States to eastern Texas. Records of males taken at Sherman Co., Kans., and Yankton, S. Dak., may be open to question.

PREY RECORD.—*Bruchus* sp., Alhambra, Calif., July 14, 1921 (A. O. Larson).

PLANT RECORD.—*Acacia* sp. (Arizona, New Mexico), *Acacia angustissima* (Arizona), *Acacia greggii* (Arizona), *Achilles* sp. (Idaho), *Adenostom* sp. (California), alfalfa (Arizona, Utah), *Aplopappus* sp. (Arizona), *Asclepias* sp. (Arizona, California), *Atriplex* sp. (Utah), *Baccharis* sp. (Arizona), *Baccharis douglasii* (California), *Baccharis emeryi* (California), *Chilopsis saligna* (New Mexico), *Chilopsis linearis* (Arizona), *Chrysothamnus* sp. (California, Utah), *Cissus trifoliata* (Arizona), *Cleomelia* sp. (Idaho), *Cleome lutea* (Oregon), *Condalia* sp. (Arizona), cotton (Arizona), *Croton californicus* (California). *Eriogonum* sp. (Idaho, Oregon, Utah), *Eriogonum* (annual, California), *Eriogonum eletum* (Oregon), *Eriogonum fasciculatum* (California), *Eriogonum fasciculatum polifolium* (California), *Eriogonum gracile* (California), *Eriogonum inflatum* (California), *Gaillardia amblyodon*

(Texas), *Gnaphalium* sp. (California), *Gnaphalium beneolens* (California), *Gutierrezia sarothrae* (California), *Helianthus* sp. (Idaho), *Helianthus annuus* (California), *Larrea* sp. (California), *Polygonum* sp. (Arizona), *Polygonum lapathifolium* (California), *Salix taxifolia* (Arizona), *Salsola kali* (Utah), *Sapindus saponari* (Arizona), *Solan elegan* (Arizona), *Solidago* sp. (California, Oregon), *Tamerix gallica* (California), *Xanthium spinosum* (California).

13. *Cerceris crandalli*, new species

FIGURES 13, 116a,b,c

FEMALE.—Length 8 mm. Black to dark amber with creamy-white and light yellow markings; normally pitted and clothed with very short silvery hairs.

Head about one-fifth wider than the thorax; black except for large frontal eye patches, small spot on the clypeal process, oval spots back of the compound eyes, elongate patches on the vertex back of the ocelli, patches on the mandibles and the scape, all of which are creamy white; clypeal border with a broad rounded slight extension mesad, on each side of which is a small denticle; clypeal process scoop shaped but much broader than long with the free border deeply emarginate; mandibles with two distinct, centrally located denticles, the apical one much the larger and more rounded; antennae normal in form, scape creamy white, peduncle and flagellum amber.

Thorax black except for two elongate patches on the pronotum, two spots on the scutellum, the metanotum, patches on the pleuron below the wing base, the tegulae, and the apex of the mesosternal tubercle, all of which are creamy white; tegulae smooth and not elevated; enclosure deeply ridged subparallel to the metanotum; mesosternal tubercle medium in size; legs dark amber to near the apical ends of the femora, the remainder of the leg parts are yellow to light amber except for dark patches on all tibiae; wings subhyaline, cloudy at the apex.

Abdomen black except for a small patch on tergum 1, a broad band on the posterior half of tergum 2, narrow bands on terga 3 and 4, and a small patch on tergum 5, all of which are light yellow; venter black, immaculate; pygidium with sides convex, basal end about one-half the greatest width, and the apical end broadly rounded.

MALE.—Length 7 mm. Black with creamy-white to light yellow markings; punctation average; pubescence short.

Head about one-fifth wider than the thorax; black except for large frontal eye patches and the scape, which are light yellow; clypeal

border with three small denticles, the medial one the largest; hair lobes subequal to the lateral clypeal lobes; mandibles without denticles; antennae normal in form, fulvous but slightly darker above.

Thorax black except for a divided band on the pronotum, the metanotum, a minute spot on the pleuron below the wing, and a patch on the tegulae, all of which are creamy white; tegulae smooth and not elevated; enclosure deeply ridged subparallel to the metanotum; mesosternal tubercles absent; legs black basally to near the apical ends of the femora, which are creamy white; tibiae and other apical segments creamy white except for the apical half of the 3rd tibia, which is dark fuscous to black; the light tip of the 3rd femur cut off from the dark area abruptly at right angles to the femur as in *C. acanthophila* Cockerell; wings subhyaline but clouded apically; stigma dark.

Abdomen black with a small semidivided spot on tergum 1, a broad band on the posterior half of tergum 2, narrow bands on the posterior margins of terga 3, 4, and 5, and a small patch on tergum 6, all of which are creamy white; venter black, immaculate; pygidium with sides convex and both ends rounded.

The male is very near that of *C. acanthophila* Cockerell, from which it may be distinguished by a creamy-white face and the relatively smooth enclosure of the latter species.

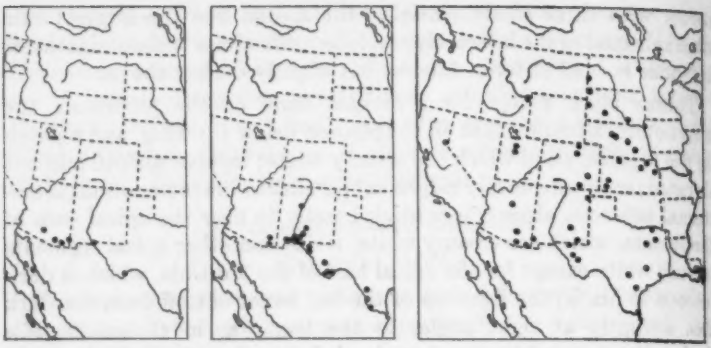
TYPES.—The type female from Tucson, Ariz., June 13, 1938, (R. H. Crandall), is deposited at the U.S. National Museum, no. 66156. The allotype male, from 8 miles southeast of Elota, Sinaloa, Mexico, 1962 (F. D. Parker), is deposited at the University of California, Davis, Calif.

ARIZONA: ♀, 10 mi. E. Gila Bend, June 15, 1955 (G. D. Butler); 4♀♀, 2 mi. NE. Portal, Cochise Co., July 30–Aug. 5, 1959, *Baccharis* (M. Statham); ♀, Sahuarita, July 5, 1956 (G. D. Butler); 3♀♀, Toltec, Pinal Co., June 14–15, 1953 (T. R. Haig); ♀, Tombstone, July 27, 1955, *Mortonia scalrella* (Butler-Werner); 2♀♀, Tucson, June 10, 13, 1938 (R. H. Crandall); ♀, Tucson (F. H. Snow). TEXAS: ♀, Boquillas, Brewster Co., June 30, 1928 (F. M. Gage); ♀, 20 mi. N. El Paso, June 19, 1942 (H. A. Scullen). MEXICO: *Sinaloa:* 5♀♀, 16♂♂, 8 mi. SE. Elota, May 18–19, 1962 (F. D. Parker, L. A. Stange); 2♀♀, 3♂♂, Cocorit, May 23, 1962 (F. D. Parker, L. A. Stange); ♀, 2♂♂, 5 mi. S. Magdalena, May 25, 1962 (F. D. Parker, L. A. Stange); ♀, ♂, 5 mi. W. Santa Ana, June 10, 1962 (F. D. Parker).

DISTRIBUTION.—Southern Arizona, western Texas, and northwestern Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Baccharis* (Arizona), *Mortonia scalrella* (Arizona).



FIGURES 13–15.—Localities of: 13, *C. crandalli* Scullen; 14, *C. crotonella* Viereck and Cockerell; 15, *C. echo echo* Mickel.

14. *Cerceris crotonella* Viereck and Cockerell

FIGURES 14, 117a,b,c

Cerceris crotonella Viereck and Cockerell, 1904, p. 139.—Scullen, 1951, p. 1007.

FEMALE.—Length 8 mm. Color black and reddish amber, marked with creamy white; normally pitted; clothed with very short silvery hairs.

Head one-fourth wider than the thorax; black except for large frontal eye patches, the clypeus, basal half of mandibles, patch on the front, round spots back of the compound eyes, and the scape, all of which are creamy white; clypeal border with five subequally spaced low denticle-like processes; process on the clypeal surface extended to form a truncate cone with the end slightly broadened and black; mandibles with two separate, subequal denticles, medially located; antennae normal in form, scape creamy white, peduncle and flagellum light amber below, darker above.

Thorax, exclusive of the propodeum, black except for two elongate patches on the pronotum, two patches on the scutellum, the metanotum, patches on the pleuron below the wing attachments, and the tegulae, all of which are creamy white; tegulae smooth and not elevated; propodeum reddish amber except the enclosure, which is black; enclosure deeply pitted along the border and along the central groove with a few incomplete ridges next to the mentanotum; mesosternal tubercle absent; legs dark amber basally to a little beyond the middle of the femora; apical ends of femora, the fore- and midtibiae, and the hindtibiae in part, creamy white; tarsi amber, becoming darker on the mid- and hindlegs; wings subhyaline.

Abdomen: terga 1 to 3 reddish amber with narrow creamy-white bands; terga 4 to 5 black with creamy-white bands; tergum 6 black,

immaculate; venter reddish amber anteriorly, becoming dark amber posteriorly; pygidium broader basally and rounded, the apical end narrowing and truncate.

MALE.—Length 6 to 7 mm. Black with creamy-white and ferruginous markings; punctation more widely spaced than average; pubescence short.

Head slightly wider than the thorax; black except for the face, base of mandibles, and scape, all of which are creamy white; clypeal border with three subequal low denticles on the medial lobe; hair lobes extend over about three-fourths of the lateral clypeal lobes; surface of the medial lobe convex; mandibles without denticles; antennae normal in form, scape largely creamy white, flagellum largely fulvous.

Thorax black except for two elongate patches on the pronotum, two large spots on the scutellum, the metanotum, a small patch on the pleuron, and the tegulae, all of which are creamy white; tegulae low and smooth; enclosure with a pitted medial groove and deeply rugose laterally; mesosternal tubercle absent; legs black to the apical ends of the femora, beyond which they are creamy white except for the apical segments of the tarsi, which become darker; the hindtibiae and the hindtarsi dark except for a large, creamy patch on the tibiae; wings are subhyaline, stigma black.

Abdomen black or dark fuscous except the first segment and the basal part of the second segment, which are ferruginous, and the following creamy-white markings: broad bands on terga 2 and 3, which have the anteriolateral corners darkened, narrow bands on terga 4 and 5, an evanescent patch on tergum 6; venter with minute, creamy spots laterally on sternites 3 and 4; pygidium with sides convex and the apical end slightly smaller than the basal end.

The male of *crotonella* Viereck and Cockerell is close to the males of *C. conifrons* Mickel and *C. bridwelli* Scullen. They are distinguished from *conifrons* by the more closely crowded punctation and narrow light bands on the abdomen of the latter. They are distinguished from *bridwelli* by having only two broad bands on the abdomen while the latter has three. The surface punctation is similar to *bridwelli*.

TYPE.—The type female of *C. crotonella* Viereck and Cockerell, taken at Las Cruces, N. Mex., on Sept. 25, 1895, *Croton neomexicanum* (Cockerell), is at the Philadelphia Academy of Natural Sciences, no. 10039.

DISTRIBUTION.—Southern Arizona, New Mexico, and southwestern Texas.

PREY RECORD.—None.

PLANT RECORD.—*Acacia augustissima* (Arizona), *Chilopsis* sp. (New Mexico), *Crotonella neomexicanum* (New Mexico), *Larrea tridentata* (Texas), *Opuncta* sp. (Texas), *Pectis pepposa* (New Mexico).

15a. *Cerceris echo echo* Mickel

FIGURES 15, 118a,b,c

Cerceris echo Mickel, 1916, p. 412.—Mickel, 1917b, p. 453.—Scullen, 1951, p. 1067. *Cerceris rufinoda crucis* H. S. Smith, 1908, p. 370 (in part).

FEMALE.—Length 9 to 10 mm. Color black and reddish amber with yellow markings; closely and deeply punctate; clothed with very short silvery hairs.

Head one-sixth wider than the thorax, black except large lateral eye patches, small spots back of the compound eyes, basal end of mandibles, and patch on scape, which are yellow; clypeal border with two widely separated broad extensions, between which is a single denticle, and laterad of each extension is a low denticle-like process; clypeal surface process is in the form of a low transverse ridge with the extremities dentiform; mandibles with one centrally located denticle, more apicad of which is a low rounded elevation; antennae normal in form, scape yellow to light amber, peduncle amber, flagellum light amber below, dark above.

Thorax, exclusive of the propodeum, black except for two elongate patches on the pronotum, two spots on the metanotum, and patch on the tegulae, all of which are yellow; tegulae sparsely pitted and slightly elevated; propodeum dorsally reddish amber except for the enclosure, which is black; enclosure deeply pitted and rugose with a prominent central groove; mesosternal tubercle small and black; legs largely amber basally, becoming more yellow beyond the middle of the femora; wings slightly clouded.

Abdomen: tergum 1 reddish amber; terga 2 to 5 black with bands of light yellow, that on tergum 2 broader and not emarginate as are the others; venter black except for the first sternite, which is reddish amber; pygidium oval, narrowing, and rounded at both ends.

MALE.—Unknown. It may be confused with closely related species. (See note under *rufinoda rufinoda* Cresson, p. 394.)

TYPE.—The type female, taken at Monroe Canyon, Sioux Co., Nebr., Aug. 4, 1908 (C. H. Gable), is at the University of Nebraska.

DISTRIBUTION.—Widely distributed but not collected in any great numbers over the Central Plains States from southern Canada to the Mexican border. Recorded from Alberta, Idaho, Montana, North Dakota, South Dakota, Minnesota, Iowa, Nebraska, Kansas,

Colorado, California, Utah, Arizona, New Mexico, and Texas. An isolated record from Independence Lake, Sierra Co., Calif., July 20, 1954 (R. C. Blaylock), is of special interest.

PREY RECORD.—None.

PLANT RECORD.—*Aster* sp. (Kansas), *Baccharis* sp. (Texas), *Chrysothamnus* sp. (Utah), *Eupatorium serotinun* (Texas), parsnip (Texas), *Pastinaca sativa* (Texas), *Solidago* sp. (New Mexico), *Thelesperma gracile* (Kansas).

15b. *Cerceris echo atrata*, new subspecies

FIGURE 16

FEMALE.—This is the same in structure and color pattern as *C. echo echo* Mickel except that the markings are light yellow and it lacks the reddish amber on the propodeum and the first abdominal segment so characteristic of the latter.

MALE.—Unknown. It may be confused with the male of *C. rufinoda rufinoda* Cresson, with which it is closely related.

This is the eastern form of *C. echo* Mickel. From manuscript labels by Banks found on some specimens, it is evident he had at one time expected to describe this form as a new species under the name of *nigroris*.

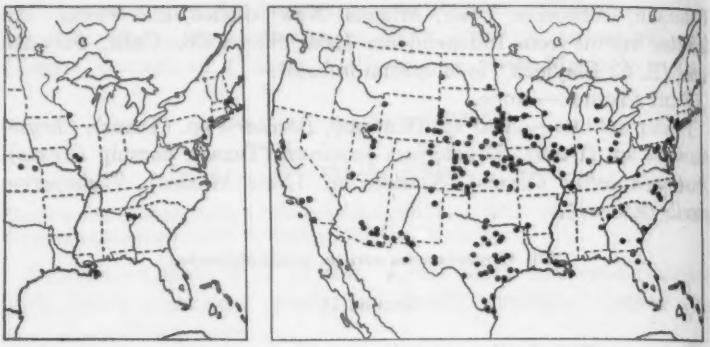
TYPES.—The type female, from Camden Co., N.J., July 12, 1891 (Wm. J. Fox), is at the Philadelphia Academy of Natural Sciences, no. 5039. Paratypes are as follows:

GEORGIA: 4 ♀ ♀, Atlanta, June 14, 1936 (P. W. Fattig); ♀, Cedartown, June 7, 1936 (P. W. Fattig). ILLINOIS: ♀, Carlinville (Charles Robertson, 6129); ♀, Meredosia, Aug. 22, 1917, sand pit. IOWA: ♀, Sioux City, Aug. 11, 1928 (C. N. Ainslie). KANSAS: ♀, Baldwin, July (Bridwell); ♀, Douglas Co., 900 ft., (F. H. Snow); 2 ♀ ♀, Riley Co., July 14, 25 (Pepenoe, 5342). MASSACHUSETTS: ♀, Forest Hills, July 1913 (F. X. Williams); ♀, Hopkinton Forest, Aug. 22; ♀, Reading, July 14, 1935, Umbelliferae flowers (Richard Dow). MAINE: ♀, Desert of Maine, Aug. 13, 1950. NORTH CAROLINA: ♂, (Cresson). NEW JERSEY, 6 ♀ ♀, Camden Co., July 12, 1891 (Wm. J. Fox). NEW YORK: ♀, Ardsley, Westchester Co., Aug. 9, 1958 (G. R. Ferguson); ♀, Bedford, Westchester Co., July 20, 1957 (G. R. Ferguson); 2 ♀ ♀, Hartsdale, Westchester Co., July 14, 1957 (G. R. Ferguson); 2 ♀ ♀, Pound Ridge, Westchester Co., July 21, Aug. 17, 1957 (G. R. Ferguson). VIRGINIA: ♀, East Falls Church, July 20 (S. A. Rohwer); ♀, Vienna, Aug. 11, 1935 (J. C. Bridwell). WISCONSIN: ♀, Genoa, Vernon Co., July 7–12, 1911 (53145).

DISTRIBUTION.—Limited through the Eastern States east of the Mississippi River.

PREY RECORD.—None.

PLANT RECORD.—Umbelliferae (Massachusetts).



FIGURES 16, 17.—Localities of: 16, *C. echo atrata* Scullen; 17, *C. finitima finitima* Cresson.

16a. *Cerceris finitima finitima* Cresson

FIGURES 17, 119a,b,c

Cerceris finitima Cresson, 1865, p. 125.—Packard, 1866, p. 61.—Creason, 1887, p. 282.—Schletterer, 1887, p. 491.—Robertson, 1890, p. 200; 1891, p. 570; 1892b, p. 108; 1892c, p. 274; 1894a, pp. 455, 457.—Dalla Torre, 1897, p. 460.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Viereck and Cockerell, 1904, p. 138.—Smith, H. S., 1908, p. 370.—Banks, 1912a, p. 27.—Stevens, 1917, p. 422.—Rohwer, 1917, p. 244.—Mickel, 1917b, p. 453.—Rau, 1928, p. 338.—Strandtmann, 1945, p. 312.—Scullen, 1951, p. 1007.

Cerceris finitima var. *nigroris* Banks, 1912a, p. 27.—Mickel, 1917b, p. 453.—Scullen, 1951, p. 1008.

FEMALE.—Length 7 to 8 mm. Color black and yellow, closely and deeply pitted, clothed with very short silvery hairs.

Head one-fourth wider than the thorax, black except large frontal eye patches on the face, the clypeus, patch on front above the clypeus, basal part of the mandibles, the scape, spots back of the compound eyes, all of which are yellow; markings on face lighter than other markings; clypeal border with two widely separated denticles; clypeal surface with a very low, broad ridge ending laterally in two slightly extended subhyaline points appearing just above and mesad of the two dark border denticles; mandibles with two subequal denticles distinctly separated and medially located; antennae normal in form, scape yellow, peduncle dark amber, flagellum light amber below and darker above.

Thorax black except for two elongate patches on the pronotum, two patches on the scutellum, the metanotum, a dot on the pleuron below the wing base, and the tegulae, all of which are yellow; tegulae elevated and pitted; enclosure transversely rugose; mesosternal tubercles small and black; legs dark amber to middle of the femora or beyond, yellow beyond to the tarsi, which are light amber; wings subhyaline except the stigma, which is dark amber.

Abdomen with deeply emarginate bands of yellow on terga 1 to 5, wider on tergum 3; venter immaculate; pygidium oval with both ends rounded, the basal end more acute.

MALE.—Length 6 to 7 mm. Color black and yellow, closely and deeply pitted, clothed with very short silvery hairs.

Head about one-fifth wider than the thorax; black except for the face, which is yellow; clypeal border with three subequal, centrally located denticles; mandibles smooth; antennae normal in form, scape yellow, peduncle dark amber and flagellum light amber below, dark above.

Thorax black except for elongate patches on the pronotum, two patches on the scutellum, the metanotum, small spots on the pleuron below the wing bases and the tegulae, all of which are yellow; tegulae elevated and pitted; enclosure deeply rugose transversely; mesopleural tubercle absent; legs dark amber basally to the middle of the femora or a little beyond, yellow beyond, becoming light amber on the tarsi; wings subhyaline.

Abdomen black except for a patch on the first tergum, broad band on tergum 2, narrow bands on terga 3 to 6 emarginate, which are yellow; venter dark amber with a tendency for yellow spots to appear laterally on sternites 3 to 5; pygidium oval with the basal end rounded, apical end more truncate.

TYPES.—The type female of *C. finitima* Cresson, from Illinois (Dr. Lewis), is at the Philadelphia Academy of Natural Sciences, no. 1948. The type male of *C. finitima* var. *nigroris* Banks, from Falls Church, Va., is at the Museum of Comparative Zoology, Harvard University, no. 13768.

The writer does not consider the variety *nigroris* Banks distinctive enough to recognize it as a subspecies.

DISTRIBUTION.—Widely distributed throughout the states east of the Rocky Mountains except in New England. It ranges from southern Canada to the Mexican border. It is found also in California, from Davis south, and into Arizona and New Mexico.

PREY RECORD.—*Chaetocnema pulicaria*, a flea beetle (Chrysomelidae), Columbus, Ohio (Strandtmann, 1945, p. 312).

PLANT RECORD.—*Acacia* sp. (Texas), *Asclepias* sp. (Arizona, Nebraska, New Mexico), *Aster* sp. (Kansas), *Bifora americana* (Texas), *Cassia* sp. (Texas), celery (Utah), *Cleome serrulata* (Nebraska), clover (Illinois), cowpeas (Arkansas), *Croton californicus* (California), *Daucus carota* (Ohio), *Dichro phyllum* (Colorado), *Erigeron quercifolius* (Florida), *Grindelia* sp. (South Dakota), *Grindelia squarrosa* (Utah), *Helianthus pumilus* (Colorado), *Kuhnistera oligophylla* (North Dakota), *Melilotus alba* (Nebraska), *Monarda citriodora* (Texas), pea vine (Ohio), *Polygonum auberti* (California), *Sambucus canadensis* (Ohio),

Solidago sp. (Colorado, Iowa, Kansas, Nebraska, Texas), *Telesperma gracile* (Utah).

16b. *Cerceris finitima citrina*, new subspecies

FIGURE 18

FEMALE.—Length 6 to 7 mm. Color black with yellow markings covering over fifty per cent of the body surface; deeply and closely pitted; clothed with short silvery hairs.

Head about one-fifth wider than the thorax; black but with the yellow markings covering most of the face, basal half of the mandibles, scape, and large irregular patch extending from one gena through vertex to the opposite gena; clypeal border with two widely separated denticles; clypeal surface with a very low, broad ridge ending laterally in two slightly extended subhyaline points appearing just above and mesad of the two dark border denticles; mandibles with two centrally located but distinctly separated denticles, the more apical one much the larger and pointing distally; antennae normal in form, the scape yellow, peduncle amber and the flagellum light amber below but darker above.

Thorax black except for a broad band on the pronotum, two short stripes on the scutum, the scutellum, the metanotum, large patches on the propodeum, two large patches on each pleuron, two small spots on the sternum, and the tegulae, all of which are yellow; tegulae elevated and lightly pitted; enclosure black, transversely rugose; mesosternal tubercle present, partly yellow; legs largely yellow except for small dark patches on the basal areas of each leg; wings subhyaline except the stigma, which is amber.

Abdomen with broad yellow bands on terga 1 to 5, those on terga 3 to 5 somewhat emarginate; pygidium oval, broader basally, apical end rounded, basal end truncate; venter dark amber except for a mesal and two lateral yellow patches on sternites 2 to 4.

MALE.—Length 6 to 7 mm. Color black with yellow markings; deeply and closely pitted; clothed with short silvery hairs.

Head about one-third wider than the thorax; black except entire face, elongate patches on the genae, the vertex, basal two-thirds of the mandibles, and the scape, all of which are yellow; border of clypeus sinuate with two lateral and one medial slight extensions; clypeal surface convex; mandibles smooth; antennae normal in form, scape yellow, peduncle amber, flagellum light amber below, darker above.

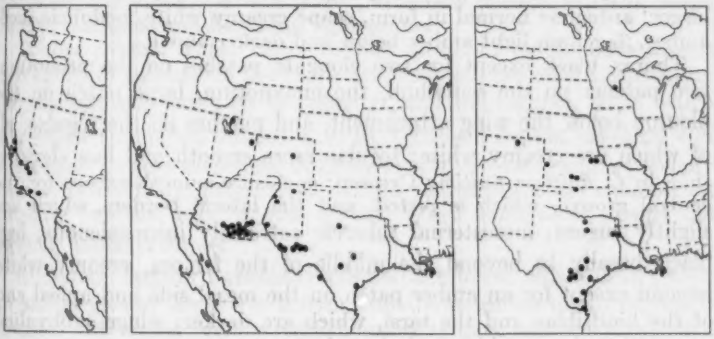
Thorax black except for two elongate patches on the pronotum, the scutellum, the metanotum, large triangular patches on the propodeum, two patches on the pleuron, and the tegulae, all of which are yellow; mesosternal tubercle absent; tegulae elevated and lightly

pitted; enclosure heavily rugose transversely; legs yellow except for small patches of amber on the following: coxae, all femora, the hindtibiae, and hindtarsi; wings subhyaline except the stigma, which is dark amber.

Abdomen with broad yellow bands on terga 1 to 6, those on terga 5 and 6 emarginate; venter amber with yellow bands on sternites 2 to 4 and two yellow patches on sternite 5; pygidium with sides convex and both ends subtruncate.

The extent of the yellow markings vary in both sexes. This is especially true of the yellow line on the genae, venter, and scutellum. Smaller patches may disappear. The subspecies *citrina* has far more yellow than the typical form *C. finitima finitima* Cresson.

TYPES.—The type female, from Riverside, Calif., Aug. 29, 1926, on *Polygonum lapathifolium* (P. H. Timberlake), and the allotype male,



FIGURES 18–20.—Localities of: 18, *C. finitima citrina* Scullen; 19, *C. finitima viereckі* Banks; 20, *C. irene* Banks.

from Riverside, Calif., Aug. 26, 1927 (P. H. Timberlake), are at the California Academy of Sciences. Paratypes are as follows:

CALIFORNIA: ♀, Antioch, Sept. 18, 1938 (J. W. MacSwain); ♀, Claremont (Baker); ♀, Colton, Aug. 10, 1951 (J. C. Hall); 2 ♀♀, Davis, Aug. 24, 1939 (G. E. Bohart); ♀, Davis, July 11, 1951 (E. I. Schlinger); ♂, Davis, July 11, 1954 (J. O. Downey); ♂, Davis, Aug. 20, 1950 (R. C. Bechtel); ♂, Lindsay, 1909, on *Asclepias* (W. A. Davidson); ♀, Patterson, Stanislaus Co., June (T. F. Leigh); ♀, Riverside, Sept. 23, 1924, on annual *Eriogonum* (P. H. Timberlake); ♀, Riverside, Aug. 16, 1927, on *Eriogonum gracile* (P. H. Timberlake); ♀, Riverside, Aug. 29, 1926, on *Polygonum lapathifolium* (P. H. Timberlake); ♀, Riverside, Oct. 1, 1928, on *Euphorbia albomarginata* (P. H. Timberlake); ♀, Riverside, July 17, 1940 (C. Dammers); ♂, Riverside, Sept. 20, 1933, on *Erigeron linifolius* (P. H. Timberlake); ♂, Santa Barbara, June 1907 (W. M. Giffard); ♂, Visalia, 1927, on privet (P. R. Jones).

DISTRIBUTION.—Recorded only from Davis and southern California.
PREY RECORDS.—None.
PLANT RECORDS.—As indicated under type material.

16c. *Cerceris finitima vierecki* Banks, new status

FIGURE 19

Cerceris vierecki Banks, 1947, p. 30.—Scullen, 1951, p. 1011.
Cerceris finitima vierecki Scullen, 1960, p. 80.

FEMALE.—Length 8 mm. Colors black with creamy-white markings; finely and moderately pitted; pubescence average.

Head about one-fifth wider than the thorax; black except for face and round spots back of the compound eyes, which are creamy white; clypeal border with two widely separated pointed extensions; clypeal surface slightly convex without special elevations; mandibles with two subequal denticles distinctly separated, the apical one much the larger; antennae normal in form, scape creamy white, peduncle dark amber, flagellum light amber below and darker above.

Thorax black except for two elongate patches on the pronotum, two patches on the scutellum, the metanotum, large patch on the pleuron below the wing attachment, and patches on the tegulae, all of which are creamy white; tegulae more smooth and less elevated than in *C. finitima finitima* Cresson; enclosure smooth except for the central groove, which is pitted, and the lateral borders, which are slightly rugose; mesosternal tubercle extremely inconspicuous; legs black basally to beyond the middle of the femora, creamy white beyond except for an amber patch on the mesal side and apical end of the hindtibiae and the tarsi, which are darker; wings subhyaline except the stigma, which is dark amber.

Abdomen black except for a patch on tergum 1, and emarginate bands on terga 2 to 5, which are creamy white; venter black, immaculate; pygidium oval with both ends rounded.

MALE.—The males taken in the same localities as the females of *C. finitima vierecki* are of the typical form and color pattern of *C. finitima finitima* but the markings tend to be more creamy white as is true of the females.

TYPE.—The type female of *Cerceris vierecki* Banks, taken at Tempe, Ariz., Aug. 1 (Bequaert), is at the Museum of Comparative Zoology, no. 23544.

DISTRIBUTION.—Largely throughout the Southwestern desert area of Arizona, New Mexico, and Texas; rare in Colorado and Utah.

PREY RECORD.—None.

PLANT RECORD.—*Acacia* sp. (Arizona), *Asclepias subverticillata* (Arizona), *Baccharis glutinosa* (Arizona), cotton (New Mexico),

Eriogonum abertianum neomexicana (Arizona), yellow composit (Arizona).

17. *Cerceris irene* Banks

FIGURES 20, 120a,b,c

Cerceris irene Banks, 1912a, p. 26—Scullen, 1951, p. 1008.

FEMALE.—Length 7 to 8 mm. Color dark amber, reddish amber and yellow; closely and deeply pitted; clothed with very short silvery hairs.

Head one-fifth wider than thorax; amber except face, basal half of mandibles, scape, patch on gena, and elongate patches on vertex, which are yellow; ocellar area dark amber; clypeal border with one central denticle-like process, to each side of which is a broad extension of the clypeal border; clypeal process with a broad rounded base narrowing to a truncate point; mandibles with two centrally located denticles, the apical one the larger; antennae normal in form, scape yellow, peduncle and flagellum light amber.

Thorax reddish amber below to dark amber or black above except two elongate patches on the pronotum, two patches on the scutellum, the metanotum, patch on the pleuron, and the tegulae, all of which are yellow somewhat infused with light amber; tegulae elevated and somewhat pitted; enclosure reddish amber to dark amber, deeply rugose transversely; propodeum reddish amber to amber; mesosternal tubercle present; legs reddish amber; wings subhyaline except the stigma, which is darker.

Abdomen, tergum 1 reddish amber with a broad emarginate yellow to amber patch; terga 2 to 5 with broad emarginate bands of yellow infused with amber; venter reddish amber to dark amber with reddish amber bands on sternites 2 to 3; pygidium with convex sides and truncate ends.

MALE.—The male of *irene* has not been isolated. It is probably being confused with the males of closely related species (see note under *rufinoda rufinoda* Cresson, p. 394).

C. irene Banks is extremely variable in color shade and the extent of color markings. The ground color varies from black to medium amber. The yellow patches on the pronotum and the scutellum may fuse to form bands on the respective parts.

TYPE.—The type female, from Fedor, Lee Co., Tex., June 25 (Birkman), is at the Museum of Comparative Zoology, Harvard University, no. 13781.

DISTRIBUTION.—Except for the one Minnesota record, *C. irene* Banks is found only in the Western and South Central States of Wyoming, Colorado, Kansas, Oklahoma, Texas, and Louisiana. Specimens are as follows:

COLORADO: ♀, Larimer Co., Aug. 13, 1952 (R. R. Dreisbach). KANSAS: 2♀♀, Blackjack Creek, Pottawatomie Co., July 2, 14, 1953 (Evans, Lin, Yoshimoto); ♀, Blackjack Creek, July 9, 1954 (H. E. and M. A. Evans); ♀, Madero, June 21, 1936 (W. O. Field); ♀, Madero, July 7, 1953 (H. E. Evans); ♀, Riley Co., Sept. 12 (J. B. Norton); 3♀♀, Riley Co., Sept. 17, 19 (Popenoe); ♀, Reno Co., Aug. 13–20, 1917; ♀, Stafford Co., Salt Flat Area, July 11, 1957 (H. E. and M. A. Evans); ♀, Wallace Co., 3440 ft. (F. X. Williams). LOUISIANA: ♀, Keatchie, June 14, 1905. MINNESOTA: ♀, Fridley Sand Dunes, Anoka Co., July 22, 1927 (R. W. Dawson). OKLAHOMA: ♀, Alfalfa Co., Aug. 10, 1932 (Deonier and Pritchard). TEXAS: ♀, Ballinger, Aug. 3, 1931 (R. H. Painter); ♀, Bexar Co., May 1, 1929 (H. B. Parks); ♀, Brooks Co., July 25, 1928 (R. H. Beamer); ♀, Brooks Co., July 25, 1928 (J. G. Shaw); ♀, Corpus Christi, June 28, 1942 (E. S. Ross); ♀, Fedor, Lee Co., May 7, 1909; ♀, Fedor, July 23, 1897 (Birkmann); ♀, Fort Worth, May 31, 1937 (Heard and Berjim); 4♀♀, Gillette, Karles Co., July 25, 1917; ♀, Kendall Co., July 22, 1928 (R. H. Beamer); 4♀♀, Lee Co., May 30, Sept. 21, 1906; ♀, McBade, Bastrop Co., May 12, 1934 (J. E. Gillaspy); ♀, Neuecest, April 28, 1896 (Morlatt); 4♀♀, Port Isabel, Cameron Co., June 23–27, 1956 (H. E. Evans and E. G. Matthews); ♀, Reno Co., Aug. 13–20, 1917; ♀, Rosser, July 6, 1905 (C. R. Jones); ♀, Victoria, June 24, 1917; ♀, Wallace Co., 3440 ft. (F. X. Williams). WYOMING: ♀, Summit, 8835 ft., Aug. 16, 1940 (H. E. Milliron).

PREY RECORD.—None.

PLANT RECORD.—*Gaillardia amblyodon* (Texas).

18a. *Cerceris kennicottii kennicottii* Cresson

FIGURES 21, 121a,b,c

Cerceris kennicottii Cresson, 1865, p. 128.—Packard, 1866, p. 63.—Cresson, 1872, p. 231; 1887, p. 282.—Schletterer, 1887, p. 495.—Robertson, 1890, p. 200; 1894a, pp. 457, 471; 1896b, p. 73.—Dalla Torre, 1897, p. 464.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Banks, 1912a, p. 25.—Mickel, 1917b, p. 452.—Hendrickson, 1930, p. 159.—Banks, 1947, p. 30.—Scullen, 1951, p. 1008.

Cerceris eriogoni Viereck and Cockerell, 1904, p. 139.—Scullen, 1951, p. 1007 (new synonymy).

FEMALE.—Length 8 to 10 mm. Black with yellow markings; normally pitted; clothed with very short silvery hairs.

Head about one-fifth wider than thorax; black except for large frontal eye patches, patch on clypeal process, basal part of mandibles, and scape, all of which are yellow; clypeal border with five equally spaced small processes, the central one denticle-like, the two lateral ones also denticle-like but smaller, the other two somewhat broader; clypeal process broad at the base, converging distally to a semitruncate apical end, which is sinuate, showing a small medial and two small lateral extensions; mandibles with two subequal, centrally located denticles; antennae normal in form, scape light yellow in front, peduncle dark amber, flagellum light amber below and dark above.

Thorax black except for two elongate patches on the pronotum, band on the scutellum, minute spot on the mesosternal tubercle, and

the tegulae, which are light yellow; tegulae smooth and not elevated; enclosure minutely rugose transversely, with a prominent medial groove; mesosternal tubercle present; legs black or dark amber to the apical ends of the femora, beyond which they are yellow, again becoming darker on the tibiae; hindfemora may be all black or show a lighter amber apical end; wings subhyaline except for the stigma, which is darker.

Abdomen black except for a small patch on tergum 1, deeply emarginate band on terga 2 and 4, two lateral patches on tergum 3, which may be joined to each other by a narrow or broken line, solid narrow or broken band on tergum 5; pygidium with a broad rounded base narrowing to a much smaller rounded apical end, surface appearing velvet-like; venter dark amber, immaculate.

MALE.—Length 7 mm. Black and light yellow; deeply pitted; clothed with short silvery hairs.

Head about one-fifth wider than the thorax, black except for large frontal eye patches, a patch on the medial lobe of the clypeus, base of mandibles, and scape, all of which are light yellow; clypeal border with three subequal denticles on the medial lobe; clypeal surface convex; mandibles smooth; antennae normal in form, scape yellow, peduncle light amber, flagellum light amber below, darker above.

Thorax black except for elongate patches on the pronotum, the scutellum, and tegulae, which are light yellow; tegulae smooth and not elevated; enclosure minutely rugose transversely, with a prominent medial groove; legs dark amber apically to the middle of the femora, light amber beyond, becoming darker on the tarsi; wings subhyaline except the stigma, which is amber.

Abdomen black with small patch on tergum 1, broad band on tergum 2, two lateral patches connected by a broken line on tergum 3, narrow bands on terga 4 to 5, elongate patch on tergum 6, all of which are light yellow; pygidium oval with both ends rounded and subequal, surface pitted; venter dark amber, immaculate.

C. kennicottii Cresson is quite variable over its extensive range. It varies in size, shade of yellow, and extent of yellow markings. The yellow markings are more yellow in the Eastern States (*C. kennicottii kennicottii* Cresson) and more white in the southern and western specimens (*C. kennicottii belai* Scullen). In the Southeast, the female of *C. kennicottii kennicottii* Cresson is nearest to *C. blakei* Cresson. They can be separated by the reddish amber of *C. blakei*, by the terminal border of the clypeal process, and by the difference in the tegulae. The male of *C. kennicottii kennicottii* Cresson is close to the male of *C. finitima finitima* Cresson. These usually can be separated by the elevated tegulae on *C. finitima finitima* Cresson. In the West, the female of *C. kenniccottii beali* Scullen can be separated from *C. con-*

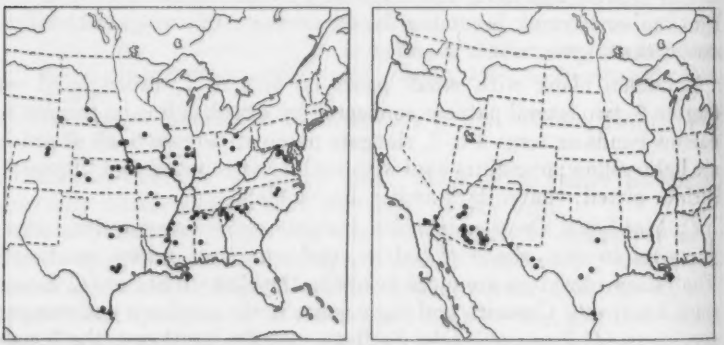
vergens Viereck and Cockerell and other closely related species by the differences in the clypeal process. The relative size of the clypeal process on the female varies. The males are difficult or impossible to separate in some cases.

TYPES.—The type male of *C. kennicottii* Cresson, from Louisiana (Robert Kennicott), is at the Philadelphia Academy of Natural Sciences, no. 1952. The type male of *C. eriogoni* Viereck and Cockerell, from Dripping Springs, Organ Mts., N. Mex., at flowers of *Eriogonum* (Cockerell), is at the Philadelphia Academy of Natural Sciences, no. 10377.

DISTRIBUTION.—Although not taken in any large numbers, this species is recorded from most of the states east of the Rocky Mountains, from southern Canada and Massachusetts south to the Gulf of Mexico, and west to Arizona. It is much more common in the South Central States.

PREY RECORD.—None.

PLANT RECORD.—*Acacia* sp. (Arizona), *Cassia* sp. (Nebraska, Texas), *Ceanothus* sp. (Virginia), *Chaerophyllum tointurieri* (Texas), *Chamaecrista fasciculata* (Nebraska), *Cicuta* sp. (Virginia), *Cicuta maculata* (Colorado, Virginia), cotton (Arizona, Texas), *Daucus carota* (North Carolina, Ohio, Virginia), *Enpatorium* sp. (Texas), *Euphorbia bicolor* (Texas), *Euphorbia marginata* (Missouri), *Helianthus tuberosa* (Kansas), *Melilotus alba* (Ohio), *Pastinaea sativa* (Colorado), *Solidago* sp. (Colorado, Texas), *Tamarix gallica* (Texas), willow (*Salix*), (Texas).



FIGURES 21, 22.—Localities of: 21, *C. kennicottii kennicottii* Cresson; 22, *C. kennicottii beali* Scullen.

18b. *Cerceris kennicottii beali*, new subspecies

FIGURE 22

FEMALE.—Length 8 mm. Black with creamy-yellow to white markings; otherwise, very close to *C. kennicottii kennicottii* Cresson.

The female type shows two breaks in the band on tergum 2 similar to the female of *C. convergens* Viereck and Cockerell but the clypeal processes are very different. Other females taken at the same time and place show the above bands varying from a solid line to a series of evanescent spots.

MALE.—Length 6 to 7 mm. Black with creamy-yellow markings; otherwise, very close to *C. kennicottii kennicottii* Cresson.

TYPES.—The holotype female and the allotype male, from Scottsdale, Ariz., May 13, 1961 (R. S. Beal), taken in copula, are deposited at the U.S. National Museum, no. 66157. Paratypes are as follows:

ARIZONA: ♀, Amado, July 3, 1957, cotton (G. D. Butler); ♂, Apache, Cochise Co., 5000 ft., Aug. 4, 1955 (R. R. Dreisbach); ♀, ♂, Avra Valley, July 6, 1955, July 5, 1957, cotton (Butler-Werner); ♀, Camp Verde, Sept. 4, 1957 (T. R. Haig); ♀, 5♂♂, Canelo, July 30, 1956, May 18, 1957, June 21, 1958 (G. D. Butler); 2♀♀, Casa Grande, May 26, 1955 (G. D. Butler); ♀, 2♂♂, same locality, June 20, July 17, 18, 1956, alfalfa (C. Williams); 2♂♂, Continental, June 14, 1955, desert willow (G. D. Butler); 2♀♀, Continental, July 27, 1956, alfalfa (C. Williams); 4♂♂, Coolidge, May 29, 1955, *Acacia* sp. (G. D. Butler); ♂, Coolidge, July 24, 1946 (H. A. Scullen); ♀, Eloy, Sept. 28, 1955, alfalfa (G. D. Butler); ♀, Eloy, June 20, 1956, alfalfa (G. D. Butler); ♀, Kansas Settlement, July 28, 1955 (Butler-Werner); ♀, Litchfield Park, June 11, 1954, alfalfa (G. D. Butler); ♀, ♂, Marana, July 6, 1956, July 5, 1957, mesquite, mustard (G. D. Butler); ♂, Marana, July 27, 1956, cotton (C. Williams); 5♂♂, Marinette, July 6, 1950 (R. H. Beamer); 2♀♀, Mesa, June 9, 1955, alfalfa (G. D. Butler); ♂, Oak Creek Canyon, July 9, 1952 (R. H. Beamer and party); ♀, Patagonia, May 21, 1955, mustard (G. D. Butler); ♀, Phoenix, Sept. 17, 1933 (R. H. Crandall); ♂, Phoenix, Aug. 8, 1950 (R. S. Beal); ♂, Phoenix, May 27, 1938 (Christenson); ♀, Phoenix, 1100 ft., Aug. 10, 1946 (H. A. Scullen); ♀, Portal, June 10, 1961 (H. A. Scullen); ♂, Portal, 5000 ft., Aug. 5, 1955 (R. R. Dreisbach); ♀, Queen Creek, July 13, 1956, cotton (C. Williams); ♀, Safford, June 24, 1954 (G. D. Butler); 4♀♀, 4♂♂, Scottsdale, June 12, 1961 (R. S. Beal); ♀, 9 mi. E. Superior, July 23, 1956 (Butler-Gerhardt); ♀, Superior, Boyce Thompson Arboretum, July 23, 1955 (G. D. Butler); ♂, Tempe, Aug. 20, 1956, alfalfa (C. Williams); ♀, Vernon, July 25, 1956 (Butler-Gerhardt); ♀, Yarnell to Prescott, July 23, 1942 (H. A. Scullen); ♀, Yuma, July 31, 1956, vetch (C. Williams); 2♂♂, Yuma Valley, June 14, 1957, July 11, 1956 (G. D. Butler). CALIFORNIA: ♂, Blythe, Riverside Co., July 8, 1956 (L. A. Stange); 2♂♂, Calexico, Imperial Co., July 11, 1957, Sept. 23, 1957 (E. I. Schlinger); ♂, Gordons Wells, Imperial Co., Aug. 29, 1957 (E. I. Schlinger); ♀, Ripley, Riverside Co., Aug. 16, 1946, *Helianthus annuus* (P. D. Hurd); ♀, 4♂♂, Seeley, July 17, 1940 (R. H. Beamer and party). NEW MEXICO: ♂, Rodeo, 4000 ft., Aug. 3, 1959 (H. E. Evans). TEXAS: 2♂♂, Alpine, July 8, 1942 (H. A. Scullen); ♂, Austin; ♂, Bexar Co., 535 ft., April 1929, *Gaillardia amblyodom* (H. B. Parks); ♂, Brownsville, 1921 (J. C. Bridwell); ♂, Brownsville, July 11, 1945, cotton; 2♂♂, Brownsville, May 17, 1952 (Michener and party); ♂, Dallas, Dallas Co., Oct. 4, 1952, *Solidago altissima* (L. H. Shinner); ♂, Davis Mts., July 9, 10, 1942 (E. C. Van Dyke); 2♀♀, Davis Mts., July 9, 1942 (H. A. Scullen); ♀, 2♂♂, El Paso, July 11, 1917 (J. Bequaert); ♂, Williams Co., Aug. 25, 1933 (J. E. Gillaspy).

DISTRIBUTION.—Arizona, New Mexico, and adjoining areas.

PREY RECORD.—None.

PLANT RECORD.—As indicated under paratypes.

19. *Cerceris krombeini*, new species

FIGURES 23, 122a,b,c,

FEMALE.—Length 10 mm. Black with yellow markings; punctation coarse; pubescence very short.

Head slightly wider than the thorax; black except large frontal eye patches, patch on the upper surface of the clypeal process, patch back of the eye, base of mandibles, and a patch on the scape, all of which are yellow; clypeal border with four denticles, the medial pair separated from each other by a deep depression and somewhat larger than the lateral pair; clypeal process with the free margins converging to a blunt point, below which is a pair of prominent denticles; mandibles with one distinct denticle flanked on each side by a low and indistinct denticle; antennae normal in form.

Thorax black except for a divided band on the pronotum, two patches on the scutellum, the metanotum, a small patch on the pleuron, and the tegulae, all of which are yellow; tegulae slightly inflated and smooth; enclosure smooth except for a medial groove and deep pits in the lateral angles; mesosternal tubercles small but very acute; legs black on the basal segments to or just beyond the middle of the fore- and midfemora, beyond which they are yellow, the hindfemora entirely black or fuscous, the hindtibiae yellow basally, fuscous apically, and the hindtarsi fuscous; wings subhyaline, clouded apically, and the stigma black.

Abdomen with a semidivided patch on tergum 1, a broad band with rectangular emargination on the basal end of tergum 2, broad but deeply emarginate bands on terga 3 and 4, a broad band on tergum 5; venter immaculate; pygidium with the sides convex and the ends subequal and rounded.

MALE.—Length 8 mm. Black with light yellow markings; punctation coarse; pubescence very short.

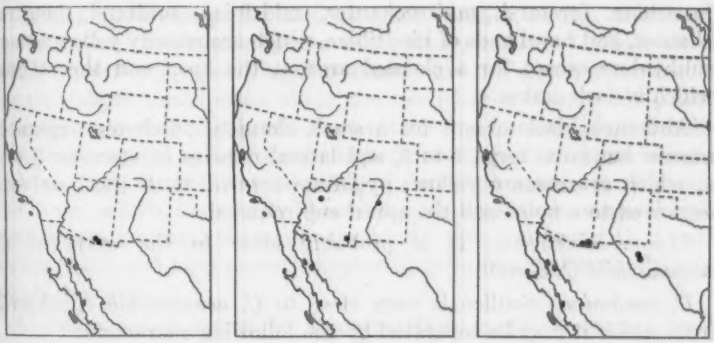
Head about one-sixth wider than the thorax; black except for the entire face, base of mandibles, and scape, all of which are light yellow; clypeal margin with three denticles on the medial lobe, the medial denticle slightly the largest; hair lobes subequal in width to the lateral clypeal lobes; surface of the medial clypeal lobe normally convex; mandibles with two very low denticles; antennae normal in form.

Thorax black except for a divided band on the pronotum, two spots on the scutellum, the metanotum, and the tegulae, all of which are light yellow; tegulae distinctly elevated but smooth; enclosure

smooth except for a medial groove and a few deep lateral pits; mesosternal tubercles absent; all legs black basally to near the apical ends of the femora, beyond which they are yellow except for a dark patch on the hindtibiae and the apical tarsal segments, which become darker; wings subhyaline but lightly clouded apically.

Abdomen black except for a small semidivided patch on tergum 1, a broad band on tergum 2, broad but deeply emarginate bands on terga 3, 4, and 5, and a band on tergum 6, all of which are yellow; pygidium with sides convex and both ends rounded and subequal in width.

The female of *C. krombeini* Scullen is very close in size, structure, and color pattern to the female of *C. astarte* Banks but it can be distinguished by the differences in the clypeal denticles, the form of the pygidium, and the color of the stigma of the wing, which is very light in the latter and black in the former.



FIGURES 23–25.—Localities of: 23, *C. krombeini* Scullen; 24, *C. neahminax* Scullen; 25, *C. poculum* Scullen.

TYPES.—The type female and allotype male of *C. krombeini* Scullen, both from Continental, Ariz., Aug. 24, 1959 (K. V. Krombein), are in the U.S. National Museum, no. 66158. Paratypes are as follows:

ARIZONA: 4 ♀♀, Continental, Aug. 2–4, 1959 (K. V. Krombein); 2 ♀♀, Madera Canyon, Santa Rita Mts., July 31, 1958 (R. M. Bohart); ♀, 10 mi. E. Nogales, Sept. 2, 1957 (T. R. Haig); ♀, 13 mi. NW. Nogales, Sept. 3, 1957 (T. R. Haig).

DISTRIBUTION.—This species is known only from 10 specimens taken in a limited area in southern Arizona.

PREY RECORD.—None.

PLANT RECORD.—None.

20. *Cerceris neahminax*, new species

FIGURES 24, 123a,b,c

FEMALE.—Length 8 mm. Color black and creamy yellow; normally pitted; clothed with short silvery hairs.

Head slightly wider than the thorax, mandibles with two centrally located subequal denticles, black except for sides of face, spot on center of front, and the clypeus, which are creamy yellow; clypeal border slightly extended centrally without denticles; clypeal process in the form of a short, thin ridge with the border approximately straight, half the width of the border extension and with a dark amber border; antennae normal in form, scape creamy yellow, peduncle dark amber, flagellum light amber below and dark amber above.

Thorax black except for two elongate patches on the pronotum, the metanotum, and the tegulae, which are creamy yellow; tegulae smooth and not elevated; enclosure smooth except for a central groove and pitted lateral borders; mesosternal tubercles absent; legs black except foretibiae, foretarsi, midtrochanter, midtibiae, midtarsi, hindtrochanter, and basal ends of hindtibiae, which are creamy yellow; wings subhyaline except for a clouded area at the apex and the stigma, which is dark amber.

Abdomen black except for a small elongate patch on tergum 1, narrow bands on terga 2 to 5, and lateral patches on sternites 3 and 4, which are creamy yellow; pygidium suboval with the basal end narrowed to a point and the apical end rounded.

MALE.—Unknown. It is probably close to the male of *C. acanthophila* Cockerell.

C. neahminax Scullen is very close to *C. acanthophila* Cockerell, from which it may be separated by the following characters:

	acanthophila	*neahminax*
pygidium:	pyriform	oval
mesosternal tubercle:	small, black	absent
mid- and hindfemora:	yellow apically	black, immaculate
mid- and hindtrochanter:	black	cream
clypeal process:	subequal in width to clypeal border extension	about half the width of the clypeal extension
clypeal border extension:	margin sinuate	margin not sinuate

TYPES.—The type female from Sante Fe, N. Mex., June 11, 1935 (E. C. Van Dyke), is at the California Academy of Sciences. Paratypes are as follows:

ARIZONA: ♀, Ashfork, July 22, 1932 (R. H. Painter); ♀, Chiricahua Mts., July 27, 1957 (D. J. and J. N. Knull). NEW MEXICO: ♀, Mountain Park, June 27, 1940 (L. C. Kuitert). UTAH: ♀, Fool Creek Pass, Aug. 17, 1938 (G. F. Knowlton, F. C. Hermston).

DISTRIBUTION.—Very rare. Arizona, New Mexico, and Utah.

PREY RECORD.—None.

PLANT RECORD.—None.

21. *Cerceris poculum*, new species

FIGURES 25, 124a,b,c

FEMALE.—Length 9 to 10 mm. Black and creamy yellow; normally pitted; clothed with silvery hairs.

Head slightly wider than the thorax; black except for large frontal eye patches, the clypeus exclusive of the free border, patch on frons, all of which are creamy yellow; clypeal border with a broad extension at the base of the process; clypeal process broad and short with the sides strongly curved downward, black along the border; mandibles with two closely joined denticles subequal in size; antennae normal in form, scape and peduncle black, flagellum amber below, dark above.

Thorax black except for two elongate patches on the pronotum, two spots on the scutellum, the metanotum, and the tegulae, all of which are creamy yellow; tegulae smooth and not elevated; enclosure faintly ridged transversely along the medial groove, sparsely pitted laterally; mesosternal tubercle absent; mid- and hindlegs black basally to near the apical ends of the femora, beyond which they are creamy yellow except for an elongate patch of dark amber on each tibia and the tarsi, which become light amber; hindlegs have coxae black, trochanters creamy yellow, femora black, tibiae yellow with a dark amber patch and tarsi amber; wings subhyaline except for the stigma, which is amber.

Abdomen black except for creamy-yellow bands on terga 1 to 5, broadly emarginate on terga 2 to 5, two lateral patches on sternites 3 and 4; pygidium long, broader, and abruptly pointed basally, gradually narrowing and rounded apically.

MALE.—Unknown.

TYPES.—The type female, taken 23 mi. NE. Douglas, Ariz., 4450 ft., Aug. 1, 1946 (H. A. Scullen), is in the U.S. National Museum, no. 66159. Paratypes are as follows :

ARIZONA: ♀, Herford, Cochise Co. (W. M. Mann). TEXAS: ♀, Alpine, July 8, 1942 (H. A. Scullen); ♀, Davis Mts., Jeff Davis Co., June 27, 1942 H. A. Scullen).

DISTRIBUTION.—Recorded only from southern Arizona and western Texas.

PREY RECORD.—None.

PLANT RECORD.—None.

22a. *Cerceris rufinoda rufinoda* Cresson

FIGURES 27; 125a,b,c

Cerceris rufinoda Cresson, 1865, p. 121.—Packard, 1866, p. 61.—Cresson, 1887, p. 286.—Schletterer, 1887, p. 491.—Robertson, 1889b, p. 303.—Ashmead, 1890, p. 32.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Viereck and Cockerell, 1904, p. 138.—Smith, H. S., 1908, p. 370.—Banks, 1912a, p. 26.—Stevens, 1917, p. 422.—Mickel, 1917b, p. 452.—Strandtmann, 1945, p. 311.—Scullen, 1951, p. 1010.

FEMALE.—Length 9 to 10 mm. Black and reddish amber with light yellow markings; deeply and closely pitted; clothed with very short silvery hairs.

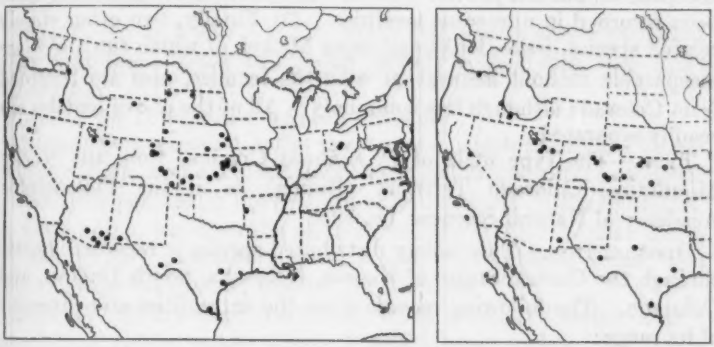
Head slightly wider than the thorax; black except for two large frontal eye patches, round spots back of the compound eyes, base of mandibles and small patch on scape, all of which are light yellow; medial lobe of the clypeal border divided into an upper and lower part, the lower part is sinuate with a distinct, medial, denticle-like process, laterad of which are two less distinct extensions; the upper part of the clypeal border appears as two semidivided rounded processes (which appear to be on the lower part of the free surface, but closer examination shows them to be embodied in the divided border as indicated above); mandibles with two subequal denticles medially located (not evident on worn mandibles); antennae normal in form, scape amber with a yellow patch, peduncle dark amber, flagellum light amber below, darker above.

Thorax black with occasional infusions of red on the propodeum and marked with light yellow as follows: elongate patches on the pronotum, two spots on the scutellum, the metanotum, spot on the pleuron, and on the tegulae; tegulae somewhat elevated and pitted; enclosure deeply pitted and with a medial groove; mesosternal tubercles small; fore- and midlegs dark amber to near the apical ends of the femora, beyond which they are yellow, turning to light amber apically; posterior legs with coxae dark amber; trochanters, femora, and remaining parts varying shades of amber; wings subhyaline except the stigma, which is darker.

Abdomen black, except first tergum is reddish amber, tergum 2 with a broad yellow band emarginate (in some specimens the reddish amber coloration extends onto the anterior part of the second tergum), terga 3 to 5 with narrow emarginate bands of yellow; venter dark amber, immaculate; pygidium narrowing basally to a small rounded point, apical end broad and subtruncate.

MALE.—Length 9 to 10 mm. Black and reddish amber with yellow markings; deeply and closely pitted; clothed with very short silvery hairs.

Head about one-fifth wider than the thorax, black except most of face below antennal scrobes, minute spots back of compound eyes, mandibles except tips, and the scapes, all of which are yellow (in some specimens the lower clypeal border has considerable black); clypeal border with three black denticles on the medial lobe; hair lobes normal in width; clypeal surface convex; mandibles smooth except for a single slight elevation, variable in size; antennae normal in form, scape yellow; peduncle dark amber, flagellum light amber below, darker above.



FIGURES 26, 27.—Localities of: 26, *C. rufinoda rufinoda* Cresson (females only); 27, *C. rufinoda crucis* Banks.

Thorax black except for two elongate patches on the pronotum, two patches on the scutellum, the metanotum, patch on the pleuron, and the tegulae, all of which are yellow; tegulae elevated to a variable amount and very lightly pitted; enclosure transversely rugose and with a medial groove; mesosternal tubercles absent; legs dark amber to amber basally to near the apical end of femora, the remainder of leg parts yellow, becoming darker on the tarsi, amber patch on apical end of hindtibiae; wings subhyaline, cloudy at apex.

Abdomen black except first tergum, which is reddish amber with a semidivided yellow patch, tergum 2 with a broad yellow band (basal black may be replaced with amber), terga 3 to 6 with narrower bands of yellow somewhat emarginate; venter reddish amber anteriorly, dark amber posteriorly; pygidium sides convex with both ends subtruncate.

The extent of the reddish amber varies considerably in different specimens. Those with the red covering most of the propodeum were described as the variety *C. rufinoda crucis* by Viereck and Cockerell. The present writer has given this form the rating of a subspecies, but this may be open to question.

A shadow of uncertainty must remain in regard to the correct identification of the males of *rufinoda* Cresson and those of closely related species (until some worker can find a positive method of separating these and other difficult males) for the following reasons: (1) After extended studies, the writer has so far found no satisfactory characters to separate the males of *rufinoda* Cresson from the males of *echo* Mickel or other unknown, closely related species. (2) The species *rufinoda* Cresson was described from a male taken in an area (Colorado) where the females of both *echo* Mickel and the female long accepted as, but not proven to be, the female of *rufinoda* Cresson have been recorded in numerous localities. (3) Finally, two other closely related species, *irene* Banks and *argia* Mickel, of which the males are inseparable without association with the females, also are recorded from Colorado although less commonly. All of the above females are readily separated.

TYPE.—The type male of *C. rufinoda* Cresson, from the Rocky Mountains, Colorado Territory (Riding), is in the Philadelphia Academy of Natural Sciences, no. 1955.

DISTRIBUTION.—This widely distributed species is recorded mostly through the Central States of Kansas, Nebraska, South Dakota, and Colorado. The following records show the extremities and diversity of its range:

ALBERTA: 2♀ ♀, Medicine Hat, Aug. 9, 1939 (E. H. Strickland). ARIZONA: ♂, 11 mi. SW. Eloy, Pima Co., June 19, 1953 (T. R. Haig); 4♂ ♂, 11 mi. NW. Ft. Huachuca, July 10, 1952 (Beamer, Liang, La Berge); ♂, Santa Rita Mts., July 10, 1952 (Beamer, Liang, La Berge); ♂, 8 mi. S. Wilcox, July 12, 1952 (Beamer, Liang, La Berge). ARKANSAS: ♀, Ouachita Mts., 25 mi. N. Ft. Smith, Aug. 30, 1939 (E. C. Van Dyke). CALIFORNIA: ♀, Hallelujah Junction, Lassen Co., July 7, 1949 (P. D. Hurd). IDAHO: ♀, Lewiston, July 18, 1925 (C. L. Fox). ILLINOIS: ♀, Carlinville, 1902 (Robertson); ♀, White Heath, Aug. 7, 1915. MONTANA: 3♀ ♀. NORTH CAROLINA: 4♀ ♀, June 14, 1927, July 16, 1926, Aug. 3, 1926, Sept. 8, 1921 (C. S. Brimley). NORTH DAKOTA: ♀, Beach, Aug. 25, 1923 (C. N. Ainslie). NEW JERSEY: ♀, Melage, Sept. 15, 1907. NEW MEXICO: ♀, 20 mi. E. Deming, 4000 ft., Aug. 2, 1946 (H. A. Scullen). OHIO: 2♀ ♀, Columbus, July 21, Aug. 2, 1941 (J. E. Gillaspy); 2♀ ♀, Franklin Co., July 17, 1942 (R. W. Strandtmann); ♀, Madison Co., June 28, 1942 (R. W. Strandtmann). OREGON: ♀, Ontario, 2150 ft., Aug. 2, 1929 (H. A. Scullen). TEXAS: ♀, Belfrage; ♀, Donna, July 21, 1933 (J. W. Monk); 2♀ ♀, Fedor; ♀, Ft. Hancock, July 9, 1917; ♀, Lee Co., June; ♀, Victoria, Victoria Co., July 25, 1917. UTAH: ♀, Lincoln, July 22, 1949 (G. F. Knowlton); ♂, Tooele, July 22, 1952 (G. F. Knowlton). VIRGINIA: ♀, Clifton, Aug. 6, 1933 (J. C. Bridwell); ♀, Falls Church, July 24, 1913 (Wm. Middleton). WYOMING: ♀, Grey Bull, Aug. 16, 1927 (H. H. Knight).

PREY RECORD.—*Tychius picirostris* (Fabricius), Madison Co., Ohio, June 29, 1942 (Strandtmann, 1945, p. 311); *Smicronyx squalidus* Casey, Columbus, Ohio.

PLANT RECORD.—*Aster* sp. (Kansas), *Ceanothus americanus* (Illi-

nois), *Chamaecrista fasciculata* (Nebraska), *Daucus carota* (Ohio), *Euphorbia* sp. (Nebraska), *Euphorbia marginata* (Kansas), *Helianthus* sp. (Nebraska), *Sium circutaefolium* (North Dakota), *Solidago* sp. (Kansas), *Thelesperma gracile* (Kansas).

22b. *Cerceris rufinoda crucis* Viereck and Cockerell, new status

FIGURE 27

Cerceris rufinoda var. *crucis* Viereck and Cockerell, 1904, p. 139.—Smith, H. S., 1908, 370.—Banks, 1912a, p. 26.—Stevens, 1917, p. 422.—Mickel, 1917b, p. 453.—Scullen, 1951, p. 1010.

FEMALE.—Length 9 to 10 mm. Black and reddish amber with light yellow markings; deeply and closely pitted; clothed with very short silvery hairs.

Head as for *C. rufinoda rufinoda* Cresson.

Thorax black except for the propodeum, which is reddish amber exclusive of the enclosure, which is black; yellow markings as follows: two elongate patches on the pronotum, broken band on the scutellum, the metanotum, patch on the pleuron, and the tegulae; tegulae elevated and pitted; enclosure rugose; mesosternal tubercle small; legs amber; wings subhyaline, clouded at the apex.

Abdomen black except tergum 1, which is reddish amber with a semidivided yellow patch; tergum 2 with a broad yellow band; terga 3 to 5 with deeply emarginate yellow bands; venter amber anteriorly becoming darker posteriorly.

MALE.—Indistinguishable.

This is being raised from a variety to a subspecies.

TYPE.—The type female, from Las Cruces, N. Mex., Sept. 25, 1895 (Cockerell), is at the Philadelphia Academy of Natural Sciences, no. 10393.

DISTRIBUTION.—Mostly in the Rocky Mountain area and occasionally west. Specimens are as follows:

CALIFORNIA: ♀, Topaz Lake, Mono Co., July 17, 1951 (A. T. McClay). COLORADO: ♀, Boulder Co., Sept. 10, 18, 1925 (C. P. Custer); ♀, Crowley Co., Aug. 4, 1933; ♀, Denver, Sept. 5, 1920; ♀, White Rock, near Boulder, 5100 ft., Aug. 13, 1919; ♀, Julesburg, Aug. 4, 1899; ♀, Jumbo Rs. [sic], Crook [Logan Co.], Aug. 12, 1901 (Sandhouse); ♀, LaJunta, 4100 ft., Aug. 12, 1920. IDAHO: ♀, Bruneau, Owyhee Co., July 22, 1952 (W. F. Barr); Hot Creek Falls, Owyhee Co., July 22, 1952 (W. F. Barr). KANSAS: ♀, McKinney Lake, Kearny Co., July 12, 13, 1954 (H. E. and M. A. Evens); ♀, Norton Co., 2270 ft., Aug. 24, 1912 (F. X. Williams); ♀, Phillips Co., 1940 ft., Aug. 30, 1912 (F. X. Williams); 4 ♀♀, Riley Co., Aug. 30, Sept. 3, 4 (J. B. Norton); ♀, Riley Co., Sept. (Marlatt). NEW MEXICO: ♀, Deming, 4000 ft., Aug. 2, 1946 (H. A. Scullen). OREGON: ♀, Ontario, 2150 ft., Aug. 2, 1929 (H. A. Scullen); ♀, 14 mi. E. The Dalles, July 17, 1929 (H. A. Scullen). TEXAS: ♀, Davis Mts., Jeff Davis Co., July 9, 1942 (H. A. Scullen); ♀, Fabens, Oct. 17, 1943 (R. W. Strandtmann); ♀, Fedor, Sept. 23, 1897 (Birkmann). UTAH: ♀, Goshen, Aug. 12, 1949 (George Bohart);

♀, Myton, Duches Co., June 30, 1958 (J. W. MacSwain); ♀, Provo (O. E. Johnson); ♀, Tooele, Aug. 23, 1937 (L. L. Hanson).

PREY RECORD.—None.

PLANT RECORD.—*Croton neomexicanum* (New Mexico), *Euphorbia* sp. (Kansas), *Helianthus* sp. (Idaho), *Solidago* sp. (Utah).

23. *Cerceris truncata* Cameron

FIGURES 28, 126a,b,c

Cerceris truncata Cameron, 1890, p. 121.

FEMALE.—Length 10 mm. Black with creamy-yellow markings; closely and deeply pitted; clothed with short silvery hairs, longer on the propodeum.

Head subequal in width to the thorax; black except for frontal eye patches, clypeal process, lower portion of the clypeus, narrow patch between the antennae, spots back of compound eyes, and base of mandibles, all of which are very light yellow; clypeal border with a broad emarginate extension mesad, laterad of which are two much smaller, irregular, denticle-like processes; clypeal process only slightly convex, about as broad as long, with the free border almost straight, smooth, rounded at the corners and amber; mandibles with two small subequal denticles; antennae dark amber except the flagellum, which is somewhat lighter below.

Thorax black except for a broken band on the pronotum, two spots on the scutellum, the metanotum, two triangular patches on the enclosure, two triangular areas on the propodeum, patch on the tegulae, and small spot on the mesosternal tubercle, all of which are light yellow; tegulae minutely pitted and not elevated; enclosure minutely pitted and faintly rugose transversely; mesosternal tubercle prominent; legs dark amber except for elongate yellow areas on all tibiae, the fore- and midtarsi; wings subhyaline except for a clouded area along the anterior half and the stigma, which is dark amber.

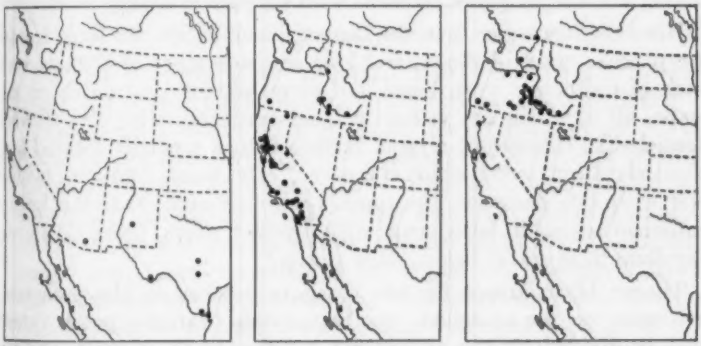
Abdomen black except for a broad band on tergum 1, narrow band on terga 2, 4, and 5, lateral spots on tergum 3, sternite 1, and most of sternite 2, small lateral spots on sternites 3, 4, and 5, all of which are light yellow; elevated area on the anterior part of sternite 3; pygidium somewhat pyriform with both ends rounded.

MALE.—Length 9 mm. Black with creamy-yellow markings; closely and deeply pitted; clothed with short silvery hairs; longer on the propodeum.

Head about one-fifth wider than the thorax; black except for large frontal eye patches, a large central patch on the clypeus, and minute evanescent spots back of the compound eyes, all of which are creamy yellow; clypeal border with a broad extension on the median lobe,

which has a sinuate margin but no distinct denticles; mandibles smooth; antennae normal in form, dark amber except the lower surface of the flagellum, which is lighter.

Thorax black except for a divided band on the pronotum, two spots on the scutellum, the metanotum, two spots on the enclosure, two triangular areas on the propodeum, small evanescent spot on the pleuron, and a patch on the tegula, all of which are light yellow; tegulae lightly pitted and not elevated; enclosure relatively smooth except for a central groove and a few deep pits along the lateral borders; mesosternal tubercle absent; legs black except for elongate areas on the sides of the tibiae and the basal parts of the tarsi; wings subhyaline except for a clouded area along the anterior half and the stigma, which is dark amber.



FIGURES 28–30.—Localities of: 28, *C. truncata* Cameron; 29, *C. sanduzeri sanduzeri* Banks; 30, *C. sanduzeri eburnea* Scullen.

Abdomen black except for a broad band on tergum 1, narrow bands on terga 2, 4, 5, and 6, small lateral spots on tergum 3, sternite 1, and small lateral spots on sternites 2 to 6, all of which are light yellow; pygidium oval with ends subequal and rounded; light yellow patches to the sides of the pygidium.

The extent of the light markings varies in both sexes. Some specimens may show little or no yellow on the face, and the spots on the enclosure may disappear.

C. truncata Cameron closely resembles *C. convergens* Viereck and Cockerell and *C. kennicottii* Cresson. In both cases the clypeal process is the best distinguishing character.

TYPE.—The type female of *C. truncata* Cameron, from Temax, Yucatan, Mexico (Gaumer), is at the British Museum, no. 21.1,433.

DISTRIBUTION.—Southern Arizona, southern New Mexico, and southern Texas.

PREY RECORD.—*Algarobius prosopis* (LeConte), *Mimosestes amicus* (Horn), *Mimosestes protractus* (Horn), *Neltumius arizonensis* (Schaeffer), all from Tucson, Ariz., in 1957–1958, by F. Werner (1960, pp. 43–44), taken on Mexican palo verde (*Parkinsonia*).

PLANT RECORD.—Casually about oleander (Arizona).

24a. *Cercoris vanduzeei vanduzeei* Banks

FIGURES 29, 127a,b,c

Cercoris vanduzeei Banks, 1917, p. 114; 1947, p. 32.—Scullen, 1951, p. 1010; 1960, p. 80.

Cercoris complanata Mickel, 1917a, p. 340.—Banks, 1947, p. 31.—Scullen, 1951, p. 1006.

FEMALE.—Length 8 to 9 mm. Black with yellow markings; closely and deeply pitted; clothed with very short silvery hairs.

Head slightly wider than the thorax; black except for large frontal eye patches, most of the central lobe and side lobes of clypeus, spot back of compound eyes, basal half of mandibles, and patch on the scape, all of which are yellow; clypeal border showing five distinct denticle-like extensions; clypeal surface with a medially located low, blunt elevation, below which is a pair of erect black denticles; mandibles with two denticles, the more apical one somewhat the larger; antennae normal in form, scape with a yellow patch, peduncle amber, flagellum light amber below, dark above.

Thorax black except for two elongate patches on the pronotum, two spots on the scutellum, the metanotum, variable patch (which may be divided) on the propodeum, patches on the pleuron, and the tegulae, all of which are yellow; tegulae smooth and not elevated; enclosure heavily ridged at 45° angle to central groove; mesosternal tubercle small; legs black basally to near apical ends of femora, beyond which they are largely yellow except for patches of amber on the tibiae, tarsi becoming darker; forefemora with a pronounced depressed area on the posterior side; wings subhyaline except for the stigma, which is amber.

Abdomen black with yellow emarginate bands on terga 1 to 5; bands on terga 2 to 5 broadly and deeply emarginate, band on tergum 2 broader than others; venter dark amber, immaculate or showing very small yellow spots laterally on some sternites; pygidium suboval with both ends rounded.

MALE.—Indistinguishable. Probably it is being confused with closely related species.

The entire face of the female may be black except for the frontal eye patches. Mandibular denticles may be worn off so that the mandibles appear smooth. The clypeal elevation and surface denticles

are similar to those of *C. conifrons* Mickel, but the two species are very distinct in other respects.

TYPES.—The type female, from San Diego, Calif., June (E. P. Van Duzee), is at the Museum of Comparative Zoology, Harvard, no. 10030. The type female of *C. complanata* Mickel, taken at Auburn, Calif., Sept. 20, 1916 (L. Bruner), is at the University of Nebraska. The allotype male of *C. complanata* Mickel, taken at the same location and date, is also at the University of Nebraska.

DISTRIBUTION.—The subspecies *C. vanduzeei vanduzeei* Banks is recorded only from California.

PREY RECORD.—None.

PLANT RECORD.—Chaparel (California), *Croton californicus* (California), *Eriogonum fasciculatum* (California).

24b. *Cerceris vanduzeei eburnea*, new subspecies

FIGURE 30

FEMALE.—Length 9 to 10 mm. Black with white markings; closely and deeply pitted; clothed with very short silvery hairs.

Head about one-fifth wider than the thorax; black except for large frontal eye patches, large spot on medial lobe of clypeus, small spot back of compound eyes, basal part of mandible, and patch on scape, all of which are white; clypeal border with five distinct denticle-like extensions on the medial section; clypeal surface with a centrally located low, blunt elevation, below which are two black denticles very close to the clypeal border; mandibles with one prominent denticle, basal of which is a very small evanescent denticle; antennae normal in form, scape with a creamy-white patch, peduncle amber, flagellum light amber below and darder above.

Thorax black except for two elongate patches on the pronotum, two spots on the scutellum, the metanotum, patch on the pleuron, and patch on the tegulae, all of which are creamy white; tegulae smooth and not elevated; enclosure heavily and irregularly ridged at a 45° angle to the medial groove and deeply pitted laterally; mesosternal tubercle present; legs black to near the apical ends of the femora, beyond which they are creamy white except for patches of amber on the tibiae and the tarsi, which are darker; wings subhyaline, becoming cloudy at the apex, except the stigma, which is amber.

Abdomen black with white bands on terga 1 to 5; bands on terga 2 to 5 emarginate; band on tergum 2 broader than others; pygidium suboval with both ends rounded; venter dark amber, immaculate.

MALE.—Unknown. Probably it is being confused with closely related forms.

The females show considerable variation in the amount of white on the face. It is common for all of the white on the face to disappear

except the frontal eye patches, which may be greatly reduced. The smaller denticle on the mandibles often is not evident.

The subspecies *C. vanduzeei eburnea* Scullen is similar in structure and color pattern to *C. vanduzeei vanduzeei* Banks except that the markings of the former are white while those of the latter are yellow.

TYPES.—The type female, from North Powder, Union Co., Oreg., July 24, 1938, *Solidago* (H. A. Scullen), is deposited with the U.S. National Museum, no. 66160. Paratypes are as follows:

BRITISH COLUMBIA: ♀, Vernon, July 18, 1947 (Hugh B. Leech). CALIFORNIA: ♀, Turlock, Stanislaus Co., June 3, 1955 (P. D. Hurd). IDAHO: 2♀♀, Acequia, Minidoka Co., June 30, 1957 (W. F. Barr); ♀, Bliss, Gooding Co., July 23, 1955 (J. E. Gillaspy); ♀, 2 mi. W. Gardens, Boise Co., July 3, 1956 (W. F. Barr); ♀, Glenns Ferry, July 8, 1927; ♀, Hagerman, July 1, 1930; 4♀♀, Hot Springs, Owyhee Co., July 4, 1951, July 12, 1952, July 5, 1956 (W. F. Barr); ♀, Kiler, Sept. 7, 1923 (Carl D. Duncan); 2♀♀, Melba, Canyon Co., July 10, 18, 1957 (H. W. Homan); ♀, Mountain Home, 3138 ft., Sept. 1, 1952 (W. F. Barr); ♀, 12 mi. NW. Regina, Ada Co., July 11, 1952 (W. F. Barr). OREGON: 2♀♀, 5 mi. NW. Adrian, Malheur Co., June 25, 1958 (R. K. Eppley); ♀, Alvoid Desert, Andrews, Harney Co., 4200 ft., July 4, 1927 (H. A. Scullen); 3♀♀, 36 mi. E. Baker, Baker Co., 2450 ft., July 31, 1929 (H. A. Scullen); ♀, Blitzen Valley, Harney Co., July 16, 1936 (S. Jewett, Jr.); 3♀♀, 3 mi. S. Elgin, Union Co., Aug. 18, 1937 (Bolinger and Jewett); 6♀♀, Grants Pass, Josephine Co., Aug. 7, 1950 (H. A. Scullen); ♀, Herford, Baker Co., 3650 ft., July 21, 1940 (H. A. Scullen); ♀, 12 mi. W. Huntington, Baker Co., 2225 ft., July 22, 1936 (H. A. Scullen); 3♀♀, 4 mi. E. Juntura, Malheur Co., 1440 ft., July 14, 1940 (H. A. Scullen); 2♀♀, Klamath Falls (Algoma), Klamath Co., Aug. 23, 1958 (Joe Schuh); ♀, North Powder, Baker Co., July 24, 1938 (H. A. Scullen); 4♀♀, Ontario, Malheur Co., July 16, 1940, *Solidago* sp. (H. A. Scullen); 6♀♀, Powder River, 26 mi. E. Baker, 3000 ft., Aug. 9, 1937 (Bolinger and Jewett); ♀, Prairie City, Grant Co., 3250 ft., Aug. 12, 1929 (H. A. Scullen); ♀, Rowena, Wasco Co., July 15, 1923 (Carl D. Duncan); ♀, Umatilla, Umatilla Co., July 14, 1931 (J. Nottingham); ♀, Unity, Baker Co., 5800 ft., July 21, 1940 (H. A. Scullen); ♀, Wilderville, Josephine Co., Aug. 4, 1949 (H. A. Scullen). UTAH: ♀, Forest Grove, Aug. 8, 1949 (G. F. Knowlton). WASHINGTON: 3♀♀, Stratford, Grant Co., July 4, 1920 (R. C. Shannon).

DISTRIBUTION.—Pacific Northwest.

PREY RECORD.—None.

PLANT RECORD.—*Achillea* sp. (Idaho, Oregon), *Chrysothamnus* sp. (Idaho), *Cleomella* sp. (Idaho), *Daucus carota* (Idaho, Oregon), *Eriogonum* sp. (Idaho), *Eriogonum elatum* (Oregon), *Helianthus* sp. (Idaho), *Melilotus* sp. (Idaho), *Solidago* sp. (Oregon).

Group II

This group is distinguished by the following characters: (1) There is no prominent elevation on the surface of the medial lobe of the clypeus; however, two small papilliform structures are just above the clypeal border. (2) The second abdominal segment is much broader than the first, especially noticeable on the female. (3) The meso-

sternal tubercle is absent from both sexes. (4) The terminal segment of the male antenna is distorted slightly. (5) The males have relatively inconspicuous denticles on the clypeal border or none at all. (6) The male hair lobes are normal in width. (7) Buprestidae are used as prey.[11]

25a. *Cerceris californica californica* Cresson

FIGURES 31, 128a,b,c

Cerceris californica Cresson, 1865, p. 128.—Packard, 1866, pp. 60, 63.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 487.—Dalla Torre, 1897, p. 454.—Ashmead, 1899, p. 295—Woodworth, 1913, p. 94.—Rohwer, 1917, p. 244.—Banks, 1947, p. 20.—Scullen, 1951, p. 1006.—Linsley and MacSwain, 1956, pp. 71–84.—Krombein, 1958a, p. 197.—Scullen, 1960, pp. 75–77.

Cerceris ferruginior Viereck and Cockerell, 1904, p. 134.—Viereck, 1960b, p. 234.—Johnson and Ledig, 1918, p. 24.—Banks, 1947, p. 25.—Scullen, 1951, p. 1007.

Cerceris garciana Viereck and Cockerell, 1904, p. 135.—Scullen, 1951, p. 1008.

Cerceris populorum Viereck and Cockerell, 1904, p. 135.—Banks, 1947, p. 25.—Scullen, 1951, p. 1009.

Cerceris cognata Mickel, 1916, p. 408.—Scullen, 1951, p. 1006.

Cerceris denticularis Banks, 1917, p. 113; 1947, p. 20.—Scullen, 1951, p. 1007.

Cerceris interjecta Banks, 1919, p. 84.—Scullen, 1951, p. 1009.

Cerceris calodera Banks, 1947, pp. 22–23.—Scullen, 1951, p. 1006.

Cerceris illota Banks, 1947, p. 23.—Scullen, 1951, p. 1008.

Cerceris isolde Banks, 1947, p. 24.—Scullen, 1951, p. 1008.

Cerceris californica californica Scullen, 1961, p. 46.

FEMALE.—Length 13 mm. Black with yellow markings, which may become amber in limited areas; closely and moderately pitted; clothed with short silvery hairs.

Head subequal in width to the thorax; face, area back of eyes, two patches on vertex, base of mandibles, scape of antennae, all are yellow; clypeal margin slightly extended from the medial lobe, emarginate in the center; clypeal surface slightly convex; clypeal surface denticles barely evident; mandibles with two denticles, the more apical one much the smaller and undivided, the more basal one larger and with two distinct apices, and the more basad of these two apices much the smaller; antennae normal in form.

Thorax black except the pronotum, tegulae, patch on pleuron, scutellum, metanotum, most of propodeum, and small spots on the enclosure, all of which are yellow with limited amber margins; tegulae not elevated, and relatively smooth except for many minute pits; enclosure finely rugose; mesosternal tubercle absent; legs yellow with some margins showing amber; wings subhyaline, cloudy in the anterior area.

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[11] Bridwell has reported an exception that occurs when buprestids are not available. See under *C. fumipennis* Say (p. 412).

Abdomen with broad bands more or less emarginate with black on anterior center, margins with some amber; venter largely yellow with limited amber; pygidium broad basally, tapering gradually to a narrow rounded end apically.

MALE.—Length 10 mm. Black to amber with yellow markings; close and moderately deep pits; clothed with short silvery hairs.

Head one-sixth wider than the thorax; face yellow below antennae except clypeal margin, which is dark amber; clypeal border slightly extended from the middle lobe with three very indistinct denticle-like extensions; clypeal surface slightly convex; mandibles without denticles; antennae normal in form except for a slight curvature of the apical segment.

Thorax black to amber with yellow markings; divided yellow band on the pronotum; scutellum black or with light spots; metanotum yellow or with a broken yellow band; tegulae not elevated, relatively smooth, yellow; enclosure smooth except for minute pits and a few large pits in the lateral angles; mesosternal tubercles absent; propodeum black to reddish amber; legs black to light amber to the apical end of the femora, largely yellow beyond; wings subhyaline, clouded along anterior border and apex.

Abdomen black with broad bands on terga 2 to 6, more or less emarginate on terga 3 to 6; tergum 1 black becoming reddish amber on some specimens; anterior half of tergum 2 becoming reddish on some specimens; venter black to more or less infused with amber and yellow; pygidium with sides subparallel and the apical end rounded.

VARIATION.—*C. californica* Cresson varies in color from the black and yellow form of the Northwest and the Rocky Mountains, represented by the type of the species, to the extremely light forms represented by *C. arno* Banks. In these lightest forms, the black has been replaced completely by very light amber to yellow. The latter are found mostly in the southwestern desert areas of California and Arizona. It is no doubt largely due to this extreme variation in color that so many species have been erected by former workers who have seen relatively few specimens representing limited areas. It is a matter of opinion which of them, if any, should be considered subspecies. The present author herein has designated the extreme lighter forms, which are more limited in their distribution, as the subspecies *C. californica arno* Banks. *Cerceris californica* Cresson may be confused with related species found in the same area such as *C. completa* Banks and *C. grandis* Banks. These are best separated by the characters given in the key.

TYPES.—The type male of *C. californica* Cresson, from California is at the Philadelphia Academy of Natural Sciences, no. 1953. The type male of *C. ferruginior* Viereck and Cockerell, from Deming,

N. Mex., is at the Philadelphia Academy of Natural Sciences, no. 10378. The type male of *C. garciana* Viereck and Cockerell, from New Mexico, is at the Philadelphia Academy of Natural Sciences, no. 10380. The type male of *C. populorum* Viereck and Cockerell, from New Mexico, is at the Philadelphia Academy of Natural Sciences, no. 10385. The type female of *C. cognata* Mickel, from Worland, Wyo., July 10, 1911 (L. Bruner), is at the University of Nebraska. The type female and allotype male of *C. denticularis* Banks, from Umatilla, Oreg., June 1882 (Samuel Henshaw), are at the Museum of Comparative Zoology, Harvard, no. 10028. The type male of *C. interjecta* Banks, from Utah, is at the Museum of Comparative Zoology, Harvard, no. 13767. The type male of *C. calodera* Banks, from Jacumba, Calif., Aug. 12, 1917 (W. M. Wheeler), is at the Museum of Comparative Zoology, Harvard, no. 27622. The type male of *C. illota* Banks, from Arizona, is at the Museum of Comparative Zoology, Harvard, no. 23541. The type male of *C. isolde* Banks, from Arizona, is at the Museum of Comparative Zoology, Harvard, no. 23540.

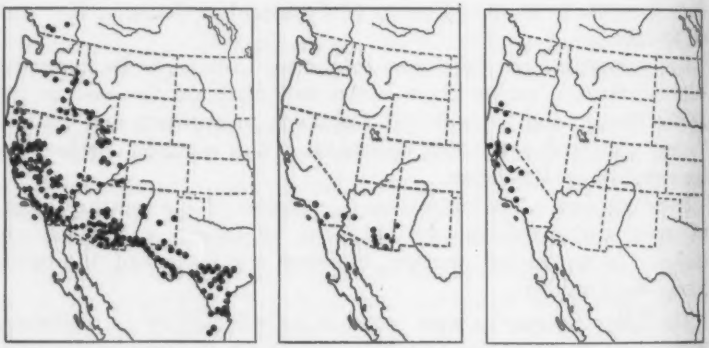
DISTRIBUTION.—*C. californica californica* Cresson, in its numerous color variations, ranges from Idaho and Utah on the east to the Pacific Ocean, and from British Columbia to southern and western Texas. Approximately 2000 specimens of this common species have been studied by the writer.

PREY RECORD.—The only intensive studies of the nesting habits and prey of this species were published by Linsley and MacSwain (1956). As would be expected, the prey was species of the beetle family Buprestidae.

The following species were found to be collected by *C. californica californica* Cresson at Tanbark Flat, San Dimas Experimental Forest, in the San Gabriel Mountains of Southern California: *Acmaeodera acuta* LeConte, *A. adenostomae* Cazier, *A. angelica* Fall, *A. coquilletti* Fall, *A. dohrni* Horn, *A. dolorosa* Fall, *A. fenyesi* Fall, *A. gemina* Horn, *A. hepburni* LeConte, *A. holsteni* White, *A. jocosa* Fall, *A. nexa* Fall, *A. perlanosa* Timberlake, *A. plagiaticauda* Horn, *A. prorsa* Fall, *A. quadriseriata* Fall, *A. sinuata* VanDyke, *Agrilus angelicus* Horn, *A. blandus* Horn, *A. politus* (Say), *Anthaxia aeneogaster* Cast, *Chrysobothris deleta* LeConte, *C. lucana* Horn, *C. femorata* (Oliver).

PLANT RECORD.—*Acacia* sp. (Chihuahua, Mexico), *A. augustissima* (Arizona), *A. greggii* (Arizona, Texas), alfalfa (Arizona), *Asclepias* sp. (Arizona, New Mexico), *A. erosa* (California), *A. mexicana* (California), *A. speciosa* (Utah), *Baccharis* sp. (Texas), *B. glutinosa* (Arizona, California), *Bebbia juncea* (California), *Cercidium texanus* (Texas), *Cleome lutea* (Oregon), *Chaenactis* sp. (California), *Chilopsis linearis*, desert willow (Arizona), *Chrysothamnus* sp. (California),

Colubbrina texensis (Texas), *Condalia* sp. (Arizona), *C. obtosifolia* (Texas), *Croton* sp. (Arizona), *C. californicus* (California), *Dalea emoryi* (California), *D. schottii* (California), *Daucus carota* (Oregon), *Dithyrea wislizeni* (New Mexico), *Eriogonum* sp. (California), *E. elatum* (Oregon), *E. fasciculatum* (California), *E. inflatum* (California), *Grindelia* sp. (California), *Helianthus* sp. (Oregon), hollyhock (Texas), *Hyptis emoryi* (California), *Isocoma helerophylla* (California), *Lepidium medium* (Arizona), *Melilotus* sp. (California), *M. alba* (Arizona, Idaho, Oregon), *Monarda* sp. (Texas), *Mortonia sacbrella* (Arizona), *Pithecolobium* sp. (Texas), *Polygonum auberti* (California), *Prosopis* sp. (California, Texas), *Rhamnus crocea* (California), *Rhus* sp. (Texas), *Salsola pestifer* (Utah), *Sapidus saponaria* (Arizona), *Solanum elaeagnifolium* (Arizona), *Solidago* sp. (Oregon), *Tamarix* sp. (Utah), *Verbesina encelioides exauriculata* (Arizona), water hemlock (Oregon), *Wislizenia refracta* (Arizona), *Yucca* sp. (New Mexico).



FIGURES 31–33.—Localities of: 31, *C. californica californica* Cresson; 32, *C. calfornica arno* Banks; 33, *C. completa* Banks.

25b. *Cerceris californica arno* Banks, new status

FIGURE 32

Cerceris arno Banks, 1947, p. 19.—Scullen, 1951, p. 1005; 1960, pp. 75–76.
Cerceris argyrotricha Rohwer, 1908, p. 324.—Scullen, 1951, p. 1005; 1960, pp. 75–76.

FEMALE.—Structurally the subspecies *C. c. arno* Banks is like the typical form of *californica* Cresson. *C. c. arno* Banks represents the extreme lighter form found in the southwestern desert area. In the lighter forms the black is more or less replaced by light amber or yellow.

Head largely yellow bordered with amber; vertex may become very

dark amber in the ocellar area; the gena and occiput are mottled with yellow and amber.

Thorax largely yellow and amber, which becomes mottled with darker shades or becomes very dark amber on the dorsum of some specimens; scutellum, metanotum, and propodeum, including the enclosure, vary from all yellow to mottled with yellow and light amber; legs have variable amounts of yellow and light amber.

Abdomen almost entirely yellow with some light amber margins.

MALE.—Males follow very much the color pattern and shades of the females.

Head largely yellow with light amber areas about the ocelli and back of the eyes.

Thorax mostly yellow with light amber areas on the scutum, becoming very dark on some specimens; legs yellow and light amber.

Abdomen largely yellow with light amber borders.

Cerceris californica Cresson is easily confused with related species found in the same areas, such as *C. completa* Banks and *C. grandis* Banks. These are best separated by the characters given in the key. The males of *C. californica arno* Banks and *C. grandis* Banks especially are difficult to separate. The surface sculpturing of the enclosure has been found most useful by the author. The enclosure of the male *grandis* shows evidence of ridges which become prominent in the females of that species, while the enclosure of the male of *californica arno* is relatively smooth except for a few pits in the lateral angles.

TYPES.—The type female of *C. arno* Banks is at the Museum of Comparative Zoology, Harvard, no. 23541, and the type female of *C. argyrotricha* Rohwer is at the U.S. National Museum, no. 28485.

DISTRIBUTION.—Southwestern desert area of California and Arizona.

PREY RECORD.—None.

PLANT RECORD.—*Baccharis glutinosa* (Arizona), cotton (Arizona), *Croton* (California), *Eriogonum albertianum neomexicanum* (Arizona), *Prosopis juliflora* (Arizona).

26. *Cerceris completa* Banks

FIGURES 33, 129a,b,c

Cerceris completa Banks, 1919, p. 83; 1947, p. 17.—Scullen, 1951, p. 1006.

FEMALE.—Length 15 mm. Black with yellow markings; normally pitted; clothed with short silvery hairs, which are somewhat longer in the region of the propodeum and the first abdominal segment.

Head slightly wider than the thorax; black except the entire face below the antennae other than the clypeal margin, base of the mandibles, the scape, two elongate patches on the vertex, and patch on the

genae bordering the compound eye, all of which are yellow; clypeal surface without elevations except two minute clypeal surface denticles just above the margin; clypeal margin with four denticle-like extensions, the lateral ones somewhat more acute than the two medial ones, which are definitely rounded; mandibles with two centrally located denticles, the basal one being the larger and more acute; antennae normal in form.

Thorax black, except for two wide patches on the pronotum, small spots on the scutellum, the metanotum, patches on the propodeum, and patches on the pleuron, all of which are yellow; enclosure deeply ridged; mesosternal tubercle absent; legs yellow except for irregular patches on the dorsal sides of the femora and limited irregular areas on the coxae and trochanters; wings subhyaline.

Abdomen: tergum 1 with lateral yellow patches; tergum 2 yellow, which all but surrounds a black area connected with the black anterior border; terga 3, 4, and 5 deeply emarginate anteriorily with a black area; tergum 6 yellow, exclusive of the pygidium, which is amber; venter largely yellow; pygidium pyriform with the apical end rounded.

MALE.—Length 11 to 15 mm. The type is smaller than most specimens examined by the author. Black with yellow markings; normally pitted; clothed with short silvery hairs, which are somewhat longer in the region of the propodeum and the first abdominal segment.

Head slightly wider than the thorax; black except the entire face below the antennae, large patch on the scape, and the base of the mandibles, all of which are yellow; clypeal surface slightly convex; clypeal border slightly extended from the medial portion and somewhat sinuate; mandibles without denticles; antennae with apical segment slightly curved.

Thorax black except widely separated patches on the pronotum, the tegulae, and a divided band on the scutellum, all of which are yellow; enclosure lightly ridged in the lateral angles; mesosternal tubercle absent; legs mostly black to near the middle of the femora, beyond which they are yellow; wings subhyaline but somewhat clouded along the anterior border; stigma light amber.

Abdomen: tergum 1 black; tergum 2 yellow with a broad black patch in the center and a black anterior margin; terga 3 and 4 with yellow partly surrounding a broad black area in the center; terga 5 and 6 largely yellow but deeply emarginate with black anteriorly; tergum 7 with yellow patches to the sides of the pygidium; venter largely yellow; pygidium with sides slightly converging to a truncate apical end.

The female is here described for the first time. *C. completa* Banks closely resembles the darker specimens of *C. californica* Cresson,

from which it can be separated by the form of the pygidium, the sculpture of the enclosure, and the color pattern of the terga.

TYPES.—The type male of *C. completa* Banks, from Claremont, Calif., is at the Museum of Comparative Zoology, Harvard, no. 13767.

DISTRIBUTION.—Scattered records through California and one record from southern Oregon. Specimens are as follows:

CALIFORNIA: ♂, Acton, Los Angeles Co., Aug. 25, 1958 (E. I. Schlinger); ♂, Auburn, 1919 (L. Bruner); 2♂♂, Buttonwillow, Kern Co., June 17, 1957; ♂, Cache Creek Canyon, Yolo Co., May 30, 1955 (E. I. Schlinger); ♂, Davis, July 11, 1948 (Brad Stevens); ♂, Deep Spring, Inyo Co., July 16, 1953 (R. M. Bohart); ♂, Deep Spring, July 16, 1953 (E. I. Schlinger); ♂, Deep Spring, July 17, 1953 (N. Malley); ♂, Deep Spring, July 17, 1953 (W. D. McLellan); ♀, Geyserville, July 31, 1927 (J. C. Bradley); ♂, Gorman, Los Angeles Co., July 13, 1956, *Asclepias mexicana* (E. G. Linsley); ♂, Gorman, Los Angeles Co., July 13, 1956 (P. D. Hurd); 2♂♂, Grass Lake, Siskiyou Co., 5000 ft., July 4, 1952 (M. Cazier and party); 2♂♂, Happy Camp, Siskiyou Co., July 8, 1958 (J. Powell); ♀, Kern Co., northwest corner of county, on U.S. 41, June 20, 1952 (W. D. Murray); ♂, Kernville, July 24, 1940 (L. S. Lipovsky); ♂, 20 mi. S. Livermore, Alameda Co., June 6, 1959 (D. J. Burdick); ♂, Lodoga, Colusa Co., July 12, 1955 (E. A. Kurtz); 3♂♂, 3 mi. N. Lone Pine, Inyo Co., July 3, 1953 (J. W. MacSwain); ♂, 2 mi. N. Lone Pine, Inyo Co., July 13, 1953 (W. D. McLellan); ♂, Los Angeles Co.; ♂, Los Gatos Creek, Mt. Diablo Range, Fresno Co., June 6–8, 1907 (Bradley); ♂, 15 mi. W. Mineral, June 16, 1941 (D. J. and J. N. Knull); ♂, Ridge Rute, Los Angeles Co., 3000–4000 ft., June 13, 1931 (Don Prentiss); ♂, Ridge Rute, June 13, 1931 (H. A. Scullen); ♂, 7 mi. S. San Antonio Ranger Station, Santa Clara Co., June 27, 1953 (R. O. Schuster); ♂, Santa Monica Mts., July 9, 1912 (J. C. Bridwell); 2♂♂, Three Rivers, 600–800 ft., July 12–14, 1907. OREGON: 2♂♂, Gold Hill, July 12, 1930 (H. A. Scullen).

PREY RECORDS.—None.

PLANT RECORDS.—*Asclepias mexicana* (California).

27a. *Cerceris dilatata dilatata* Spinola

FIGURES 34, 130a,b,c

Cerceris dilatata Spinola, 1841, p. 118.—Dalla Torre, 1897, p. 457.—Scullen, 1961, p. 46; 1962, pp. 57–8.

Cerceris maximiliani Saussure, 1867, pl. 1, p. 94.—Cameron, 1890, p. 111.—Dalla Torre, 1897, p. 467.

Cerceris contracta Taschenberg, 1875, p. 396.—Schletterer, 1887, p. 489.—Dalla Torre, 1897, p. 456.

Cerceris olymponis Strand, 1910, p. 140.

Cerceris semiatra Banks, 1947, p. 25.—Scullen, 1951, p. 1005.

FEMALE.—Length 13 mm. Color black with brownish yellow markings; normal to closely pitted; clothed with short silvery hairs. Head slightly wider than the thorax, black except for narrow frontal eye patches and base of mandibles, all of which are brownish yellow, and the first three or four segments of the flagellum, which are light brown below; clypeal border is smooth, slightly extended, and emarginate in the center; clypeal surface is elevated slightly in the

center but without a process; clypeal surface denticles almost indistinguishable; mandibles with two separated, centrally located denticles, the more apical one the smaller; antennae normal in form.

Thorax black except for two small patches of brownish yellow on the pronotum; tegulae not elevated, with many minute pits and a few large pits; enclosure surface with many minute pits and a few scattered large pits in the lateral angles; mesosternal tubercle absent; legs black except for small stripes on the tibiae and first tarsal segments of the first and second pairs of legs; wings subhyaline with a more clouded area along the anterior borders of the first pair.

Abdomen black except for a band on the posterior border of the third tergum, wide emarginate bands on terga 4 and 5, patches laterad of the pygidium on tergum 6 and most of sternites 3, 4, and 5, all of which are brownish yellow; pygidium semioval with the apical end somewhat smaller.

MALE.—Length 9–10 mm. Black with brownish-yellow markings; deeply and closely pitted; clothed with short silvery hairs.

Head slightly wider than the thorax, black except for elongate, narrow frontal eye patches; clypeal border slightly extended on the medial lobe, ending in three distinct, subequal denticles; hair lobes of the usual narrow type; mandibles without denticles; antennae largely black, terminal segments slightly curved.

Thorax black except for two irregular small patches on the pronotum; tegulae not elevated, with a few deep pits, between which are many minute pits; enclosure with an indistinct central groove, a few deep pits in the lateral angles and the general surface covered with scattered minute pits; mesosternal tubercles absent; legs black except for narrow stripes on the first two pair of tarsi; wings clouded along the anterior area.

Abdomen black except for the apical half of tergum 3, most of terga 4 to 7, and sternites 4 to 6, all of which are brownish yellow; pygidium with sides slightly convex and apical end truncate.

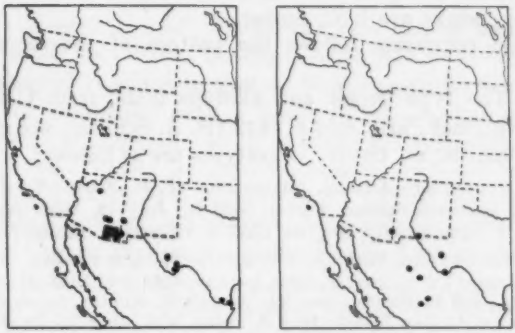
TYPES.—A neotype male of *C. dilatata* Spinola, designated by the writer, is at the Instituto e Museo di Zoologia, Università di Torino, Italy. The male and a female, both apparently determined by Spinola, are from Cayenne, French Guiana. A lectotype female of *C. maximiliani* Saussure, from Mexico, designated by the writer, is at the Museum Histoire Naturelle, Geneva, Switzerland. A lectotype female of *C. contracta* Taschenberg, from Brazil, designated by the writer, is at the Zoologisches Institut, Martin-Luther-Universität Halle (Saale), Germany. The holotype female of *C. olymponis* Strand, from Paraguay, is at the Zoologisches Museum, Humboldt Universität, Berlin. The type male of *C. semiatra* Banks, from Pati-

gonia, Ariz., is at the Museum of Comparative Zoology, Harvard, no. 27620.

DISTRIBUTION.—This species has been taken from southern Arizona, through southern New Mexico, and southern Texas. It ranges south through Mexico and Central America and into South America.

PREY RECORD.—None.

PLANT RECORD.—(All from Arizona) *Acacia* sp., *Baccharis glutinosa*, *Cephalanthus* sp., *Chilopsis linearis* (desert willow), *Cissus trifoliata*, *Condalia lycioides*, *Croton* sp., *Erigeron canadensis*, *Eriogonum* sp., *Lepidium* sp., *Melilotus alba*, *Prosopis* sp. (mesquite), *Sapindus saponaris*, *Wislizenia refracta* (jackass clover).



FIGURES 34, 35.—Localities of: 34, *C. dilatata dilatata* Spinola; 35, *C. dilatata chisosensis* Scullen.

27b. *Cerceris dilatata chisosensis*, new subspecies

FIGURE 35

FEMALE.—Length 13 mm. Black with reddish-amber and brownish-yellow markings; structurally like *C. dilatata dilatata* Spinola but colors depart from the typical subspecies by having considerable reddish amber covering most of the propodeum exclusive of the enclosure, the first abdominal segment, and extending onto the second tergum. The legs are amber and not black. Color marking otherwise more extended as indicated below.

Head black except for two large frontal eye patches and most of the medial clypeal lobe, base of mandibles, and the antennal scape, all of which are brownish yellow; clypeal margin and clypeal surface denticles are amber.

Thorax black except for two elongate patches on the pronotum, the tegulae, and the metanotum, which are brownish yellow to amber, and the propodeum, which is largely reddish; enclosure black; legs amber; wings clouded with light amber.

Abdomen differs from that of *dilatata dilatata* Spinola by having the first abdominal segment reddish with the red extending irregularly onto the second tergum; the second tergum also has a broad irregular patch of yellow along the posterior border; venter largely yellow to amber; pygidium and remainder of tergum 6 is amber.

MALE.—Length 9–10 mm. Black with reddish-amber and brownish-yellow markings; structure like that of the subspecies *dilatata dilatata* Spinola.

Head coloration typical of the subspecies *dilatata dilatata* Spinola except the antennae are somewhat lighter.

Thorax coloration pattern follows very much that of the female except the red of the propodeum is somewhat less in extent; legs are light amber; wings are light amber.

Abdominal coloration follows the pattern of the female of the subspecies.

TYPES.—The type female and allotype male, from Chisos Mts., Big Bend National Park, July 6, 1942 (H. A. Scullen), are in the U.S. National Museum, no. 66161. Paratypes are as follows:

ARIZONA: ♀, southern Arizona, August 1902 (F. H. Snow); 2♂♂, 5 mi. W. Southwestern Research Station, Portal, 5400 ft., July 18, 1956, *Melilotus alba* (M. Cazier); ♀, same locality, Aug. 24, 1956 (E. Ordway). TEXAS: 7♂♂, Chisos Mts., Big Bend National Park (J. Bequaert); ♂, same locality, July 6, 1942 (E. C. Van Dyke); 7♀♀, 16♂♂, same locality, July 3–6, 1942 (H. A. Scullen); ♂, Davis Mts., Jeff Davis Co., Aug. 22, 1936 (J. N. Knull); ♀, ♂, Davis Mts., July 10, 1942 (E. C. Van Dyke); 10♂♂, Davis Mts., June 21, 29, July 9, 1942 (H. A. Scullen); 2♂♂, Davis Mts., Madera Canyon Park, July 20, 1950 (Ray F. Smith); ♀, El Paso, June 23, 1942 (E. C. Van Dyke). MEXICO: ♀, Chihuahua, Chih., Aug. 12, 1951, *Baccharis glutinosa* (P. D. Hurd); 2♂♂, 18 mi. W. Jimenez, Chih., Aug. 10, 1951, *Baccharis* sp. (H. E. Evans); ♂, 33 mi. S. Hidalgo del Parral, 6400 ft., Oct. 24, 1957 (H. A. Scullen); ♀, 10 mi. W. Namiquipa, Chih., 6600 ft., July 3, 1947 (C. D. Michener); ♀, San Juan Del Rio, Durango, 5200 ft., July 30, 1947 (C. D. Michener).

DISTRIBUTION.—This subspecies has been taken mostly in the Chisos Mountains of the Big Bend National Park, Texas, but limited numbers have been collected in nearby mountains and in northern Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Baccharis glutinosa* (Chihauhau, Mexico), *Melilotus alba* (Arizona).

28. *Cerceris fumipennis* Say

FIGURES 36, 131a,b,c

Cerceris fumipennis Say, 1837, p. 381.—Dahlbom, 1845, p. 204.—Smith, F., 1856, p. 465.—LeConte, 1883, p. 762.—Cresson, 1865, p. 113.—Packard, 1866, p. 60.—Cresson, 1872, p. 227.—Taschenberg, 1875, pp. 397–8.—Schletterer, 1887, p. 493.—Cresson, 1887, p. 282.—Marlatt, 1890, p. 147.—

Robertson, 1892, p. 105.—Ashmead, 1894, p. 60.—Robertson, 1896, p. 73.—Dalla Torre, 1897, p. 462.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Peckham, 1900, p. 90.—Smith, J. B., 1900, p. 519.—Viereck, 1903, p. 120.—Hartman, 1905, p. 66.—Smith, H. S., 1908, p. 366.—Smith, J. B., 1910, p. 678.—Grossbeck, 1912, pp. 135, 299.—Banks, 1912a, p. 17.—Viereck, 1916, pp. 695, 696.—Mickel, 1917b, p. 447.—Britton, 1920, p. 342.—Rau, 1922, pp. 30–31; 1928, p. 338.—Cartwright, 1931, pp. 269–270.—Scullen, 1951, p. 1008.—Krombein, 1952b, p. 95.—Linsley and MacSwain, 1956, p. 74.—Evans, 1957, pp. 84–85, pl. 11.—Krombein, 1958b, pp. 101, 110.—Evans, 1959, p. 156.

Cerceris cincta Dahlbom, 1845, p. 204.—Smith, F., 1856, p. 438.—Cresson, 1887, p. 282.

Cerceris unicincta Taschenberg, 1875, p. 397.—Patton, 1880, p. 403.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 505.—Dalla Torre, 1897, p. 462.—Ashmead, 1899, p. 295.

FEMALE.—Length 15 mm. Black with very limited creamy-yellow markings; deeply and closely pitted; clothed with short silvery hairs.

Head subequal in width to thorax; black except for large patches mesad of the compound eyes, a patch on the medial lobe of the clypeus, and base of mandibles, all of which are light yellow; clypeal border with two widely separated denticles, between which is a broad extension emarginate in the center; clypeal surface denticles inconspicuous; mandibles with two distinct, medially located denticles, the basal one much the larger; antennae normal in form, black.

Thorax black except for two patches on the pronotum and the metanotum, which are creamy yellow; tegulae smooth except for a few scattered pits, not elevated; enclosure covered with minute pits, a few scattered lateral large pits, and a central groove; mesosternal tubercles absent; legs black except for elongate blotchy patches on all tibiae; wings clouded.

Abdomen black except for a broad band on tergite 2 and small lateral patches on tergite 3, which are creamy yellow, more or less blotched with black; venter black, immaculate; pygidium somewhat pyriform with the surface rugose.

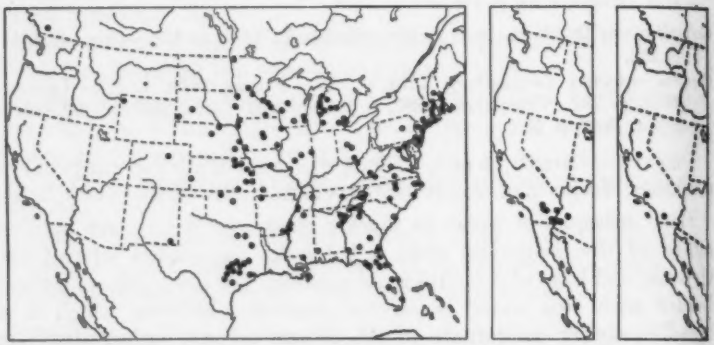
MALE.—Length 10–12 mm. Black with creamy-yellow markings; normally pitted and clothed with short silvery hairs.

Head slightly wider than the thorax, black except for large eye patches on the face; clypeal border slightly extended, with a straight margin except for a slight medial denticle; mandibles without distinct denticles; antennae black, normal in form.

Thorax black except for a broken band on the prothorax and the metanotum, which are creamy yellow; tegulae lightly pitted and not elevated; enclosure with many minute pits and a few large pits; mesosternal tubercle absent; legs black except for creamy-yellow areas on all tibiae; wings clouded.

Abdomen black with a broad band on tergum 2 and lateral patches on terga 3, 4, and 5, which may be connected by a broken line along the posterior margins of the terga; venter black, pygidium slender and elongate with both ends blunt.

Structurally, *C. fumipennis* Say is very close to *C. californica* Cresson and *C. dilatata* Spinola, but the color patterns are quite different.



FIGURES 36–38.—Localities of: 36, *C. fumipennis* Say; 37, *C. grandis grandis* Banks; 38, *C. grandis percna* Scullen.

TYPES.—Say's type male, from Indiana, apparently is lost. A neotype male, from 3 miles west of Kaskaskia River, Boulder, Ill., June 21, 1938 (D. Bolinger), has been designated by the writer and is deposited at the U.S. National Museum. The type male of *C. cincta* Dahlbom, from "America," is at the Universitets Zoologiska Institution, Lund, Sweden. The type female of *C. unicincta* Taschenberg, from "Tenn.," should be at the Zoologisches Institut, Martin-Luther-Universität, Halle (Saale), Germany.

DISTRIBUTION.—East of the Rocky Mountains to the Atlantic States and from southern Canada to the Gulf of Mexico.

PREY RECORD.—The prey-collecting habits of *C. fumipennis* Say have been observed by more workers than any other species of *Cerceris*. With the exception reported below by Bridwell, the prey always has been some species of Buprestidae. The following quotation from unpublished notes by J. C. Bridwell, on file at the U.S. National Museum, is of special interest in this connection:

> This species belongs to a natural group in *Cerceris*, of which the species in many parts of the world all, so far as known, store their nests with adult Buprestidae.
>
> The season of flight for Buprestidae ends about August 1st but the wasps are then still active. The material below illustrates the substitute used when Buprestidae are no longer present.

After the conclusion of the flight of the Buprestidae in 1933, the colony of *Cerceris fumipennis* under observation at Clifton, Virginia, stored their nests with adult beetles of the genus *Chlamisus*, Chrysomelid beetels resembling Buprestidae only in their hard integuments and in their metalic luster.

Other observers have found *C. fumipennis* Say collecting Buprestidae much later in the fall. No other observers have recorded the species collecting anything but Buprestidae.

The following species of Buprestidae have been recorded or otherwise indicated as prey of *C. fumipennis* Say: *Acmeodera pulchella* (Herbst) (Scullen, from Iowa), *Actenodes acornis* (Say) (Cartright, from S.C.), *Agrilus arcuatus* (Say) (Cartright, from S.C.), *A. bilineatus* (Weber) (Cartright, from S.C.), *A. abjectus* Horn (Rau, from Kansas), *A. ruficollis* (Fabricius), *Buprestis consularis* Gory, *B. fasciata* Fabricius, (Cartright, from S.C.), *B. lineata* Fabricius (Cartright, from S.C.), *B. maculipennis* Gory (Cartright, from S.C.), *B. rufipes* (Oliver) (Cartright, from S.C.), *B. striata* Fabricius (Cartright, from S.C.), *Chrysobothris azurea* LeConte (Evans, from Ark.), *C. blanchardi* Horn (Cartright, from S.C.), *C. dentipes* (Germer) (Cartright, from S.C.), *C. femorata* (Oliver) (Bridwell, from Kansas; Cartright, from S.C.; Scullen, from Iowa), *C. floricola* Gory (Cartright, from S.C.), *C. lesueuri* Castelnau (Cartright, from S.C.), *C. purpureovittata* Horn (Evans, from Ark.), *C. quadriimpressa* Castelnau (Peckham, from Wis.), *C. sexsignata* (Say) (Cartright, from S.C.; Scullen, from Iowa), *C. verdigripennis* Frost (Cartright, from S.C.), *Cinyra gracilipes* (Melsheimer) (Evans, from Ark.), *Conotrachelus* sp., (Hartman, from Tex.), *Dicerca caudata* LeConte (Evans, from Ind.), *D. americana* (Herbst) (Cartright, from S.C.), *D. nuttalli* var. *consularis* Gory (Cartright, from S.C.), *D. divaricata* (Say) (Scullen, from Iowa; Evans, from Ark), *D. lurida* Fabricius (Scullen, from Iowa; Krombein, from N.C.; Cartright, from S.C.), *D. obscura* (Fabricius) (Bridwell, from Kansas), *D. punctulata* (Schönherr) (Cartright, from S.C.; Grossbeck, from Long Island, N.Y.; Robinson, from Va.), *D. spreta* (Gory), *D. tuberculata* (Castelnau) (Cartright, from S.C.).

PLANT RECORD.—*Ammi majus* (Texas), *Ampelopsis arborea* (Texas), *Ceanothus* sp. (North Carolina), *C. americana* (Massachusetts), *C. canadensis* (Massachusetts), *Chinquapin* sp. (Florida), *Circuta maculata* (Ohio), *Cyrilla racemiflora* (Florida), *Daucus carota* (Florida, Ohio), *Erigeron quercifloris* (Florida), hydrangia (North Carolina), *Melilotus alba* (Florida, Iowa, Kansas, Ohio, Texas), *Monarda citriodera* (Texas, New Jersey), tea (Florida), *Polygonum hydropiperoides* (Florida), *Polytaenia nuttallii* (Ohio), *Ptillmaius capillaceum* (Florida), *Quercus virginiana* (North Carolina), *Rhus copallinum* (North Carolina), *Salix* sp. (Texas), *Solidago* sp. (North Carolina), *Spiraea telici-*

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folia (Massachusetts), *Stillingia sylvalica* (Texas), water parsnip (Texas), *Vitex negundo* (Texas).

29a. *Cerceris grandis grandis* Banks

FIGURES 37, 132a,b,c

Cerceris grandis Banks, 1913b, p. 423; 1947, p. 10.—Scullen, 1951, p. 1008.

FEMALE.—Length 19 mm. Light yellow amber with limited markings of medium amber; punctation sparse and shallow; pubescence very short except in the region of the propodeum and first abdominal segment.

Head subequal in width to the thorax; light yellow amber except patch in ocellar area, small patch on occiput and clypeal margin, all of which are light amber, and the apical part of the mandibles, which are dark amber; clypeal margin with two acute denticles opposite the junction of the middle and lateral lobes of the clypeus, and two mesal denticles that are broad and flat; clypeal surface convex with two conspicuous small surface denticles just above the clypeal border; mandibles with one broad but pointed denticle, apicad of which is a depression; antennae normal in form with the scape mostly yellow and the remaining segments light amber.

Thorax largely light yellow amber with a broad mesal stripe and two narrow lateral stripes of amber on the mesotergum and more or less amber along all sutures; enclosure heavily ridged at 45° angle to the base; legs yellow; wings subhyaline.

Abdomen all yellow; pygidium with sides narrowing abruptly to a rounded apical point.

MALE.—Length 14 mm. Coloration close to that of the female but with somewhat more amber; punctation and pubescence as in the female.

Head subequal in width to the thorax; largely yellow with dark amber stripes between the antennal scrobes and ocelli, and an irregular area of amber on the vertex; clypeal surface convex; clypeal margin extended on the medial lobe with the margin showing three inconspicuous denticle-like points; mandibles smooth; antennae normal except the apical segment, which is slightly curved.

Thorax largely light yellow amber except the mesotergum, which is light amber; tegulae not elevated and relatively smooth; enclosure smooth except for inconspicuous ridges that appear in the lateral angles.

Abdomen entirely yellow except for slight amber shading along some sutures; pygidium with sides converging slightly to a truncate apex.

C. grandis grandis Banks is very close to *C. californica arno* Banks,

from which it may be distinguished by the characters given in the key. The males especially are difficult to separate, and the writer has not yet found characters that are dependable in separating them.

TYPE.—The type female of *C. grandis* Banks, taken at Fort Yuma, Ariz., is in the American Museum of Natural History, New York, no. 21181.

DISTRIBUTION.—Southern California and adjoining areas. Specimens are as follows:

ARIZONA: ♂, Arlington, July 12, 1956, cotton (G. D. Butler); ♀, ♂, Roll, June 24, 1955 (G. D. Butler); ♂, Wellton, July 12, 1956, cotton (G. D. Butler); ♂, Yuma, July 1940 (K. D. Snyder); ♂, Yuma Valley, June 14, 1957 (G. D. Butler). CALIFORNIA: ♂, Blythe, June 23, 1946 (W. F. Barr, R. F. Smith); ♂, Coachella Valley, June 26, 1933; ♀, Imperial Co., June 1911 (J. C. Bridwell); ♀, Indio, June 27, 1936 (E. S. Ross); ♂, same locality, 1954 (G. E. Bohart); 2♂♂, 15 mi. S. Indio, June 27, 1936 (M. Cazier); ♀, northern end of Salton Sea, May 25, 1940; ♂, Thermal, Riverside Co., July 2, 1956, *Melilotus alba* (M. Wasbauer).

PREY RECORDS.—None.

PLANT RECORDS.—None.

29b. *Cerceris grandis percna*, new subspecies

FIGURE 38

FEMALE.—Length 19 mm. Structurally like *C. grandis grandis* Banks in all respects except for color. The subspecies *percna* is black with yellow markings and a limited amount of amber.

Head black or amber except face below antennal scrobies, base of mandibles, broken areas back of compound eyes, and two small patches on the vertex, all of which are yellow; entire genae outside of the above yellow areas back of the compound eyes are amber in the type but black on the paratypes; scape amber but remainder of antennae almost black.

Thorax black except for a divided band on the pronotum, two small spots on the scutellum, the entire metanotum, two large areas on the propodeum, and a small patch on the mesopleuron, all of which are yellow bordered with amber; an amber area covers much of the mesosternum; legs largely amber; wings subhyaline.

Abdomen largely yellow except for black patches in the center of all terga joining the basal border but becoming very small on the 6th tergum; venter largely yellow infused with amber.

The type appears to be somewhat discolored with cyanide. The paratype from San Diego is almost entirely black and yellow with relatively little amber.

MALE.—Unknown.

TYPES.—The type female, taken at Mokelumne Hill, Calaveras Co., Calif., 1500 ft. elevation (F. E. Blaisdell), is at the U.S. National Museum, no. 66162. Paratypes are as follows:

CALIFORNIA: ♀, Werner's, San Diego Co., Aug. 1, 1921; ♀, Los Angeles Co.

DISTRIBUTION.—Southern California.

PREY RECORD.—None.

PLANT RECORD.—None.

Group III

This group is distinguished by the following characters: (1) A distinct lamella (or lamellae) appears on the free margin of the medial clypeal process. (2) The extension of the medial clypeal lobe on the male is noticeably narrow, with three more or less distinct denticles on its margin. (3) Mesosternal tubercles are absent from both sexes or are very small. (4) The terminal segment of the male antenna is distorted slightly. (5) Chrysomelidae are used as prey to feed the young, as recorded for three species (*compacta* Cresson, *flavofasciata* H. S. Smith, and *robertsonii* Fox).

30. *Cerceris cochisi*, new species

FIGURE 39

FEMALE.—Length 14 mm. Amber and yellow with little or no black or dark amber, punctation and pubescence normal. Structurally near the female of *C. compacta compacta* Cresson except that specimens of the former are slightly larger. Enclosure somewhat smoother.

Head yellow below the antennal scrobies, two yellow spots on the vertex, and yellow patches back of the compound eyes; small dark areas between the ocelli; basal two-thirds of mandibles yellow, apical third and denticles dark amber; scape yellow and amber, remaining segments of antennae amber becoming darker apically.

Thorax amber except pronotum, scutellum, metanotum, and tegulae, which are yellow; legs light amber; wings shaded with amber.

Abdomen yellow except for tergum 1, anterior half of tergum 2, most of first 2 sternites, and the sixth segment, all of which are light amber.

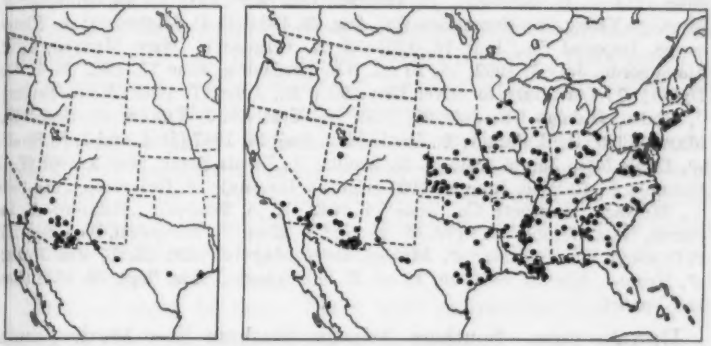
MALE.—Length 12 mm. Amber and yellow with little or no black or dark amber, punctation and pubescence normal. Structurally near the male of *C. compacta* Cresson, except that specimens average slightly larger. Enclosure somewhat smoother.

Head yellow below the antennal scrobies and patches back of the compound eyes; small black ocellar area; basal half of mandibles yellow, apical half dark; scape yellowish amber, basal half of antennae amber, apical half very dark.

Thorax dark amber, clouded with variable amounts of very dark amber; pronotum, scutellum, metanotum, and tegulae yellowish amber; legs light amber; wings lightly shaded with amber.

Abdomen yellow except first and second segments, which are largely amber.

Some males show considerably more dark amber on the thorax and anterioral abdomenal segments than the type.



FIGURES 39, 40.—Localities of: 39, *C. cochisi* Scullen; 40, *C. compacta compacta* Cresson.

TYPES.—The type female, Lordsburg to Silver City, N. Mex., over 5000 ft., June 17, 1942 (H. A. Scullen), and the allotype male, 2 mi. NE. Portal, Ariz., June 5, 1961, *Condalia lycioides* (H. A. Scullen), both at the U.S. National Museum, no. 66163. Paratypes are as follows:

ARIZONA: ♂, 3 to 5 mi. SW. Apache, Aug. 8, 1959, *Baccharis glutinosa* (H. E. Evans); ♂, Bill Williams Fork, August (F. H. Snow); 4♂♂, Boyce Thompson Arboretum, Superior, July 23, 1955, *Condalia*, *Acacia greggii* (G. D. Butler); 2♂♂, 3 mi. NW. Casabel, July 17, 1960, *Prosopis juliflora* (J. E. Gillaspy); ♂, Cedar Creek, 15 mi. W. Apache, June 21, 1957 (Butler-Werner); ♂, Congress Junction, July; ♂, Continental, Aug. 12, 1957 (G. D. Butler); ♀, 6 mi. E. Douglas, Cochise Co., Sept. 5, 1958 (M. A. Cazier); ♂, 5 mi. W. Fort Apache, June 21, 1957 (Butler-Werner); ♂, Fort Thomas, Graham Co., 2700 ft., Aug. 7, 1946 (H. A. Scullen); ♀, Granite Dells, July 5, 1950, *Nolina microcarpa* (J. G. Rozen); ♂, 15 mi. E. Pearce, July 10, 1955, *Sapindus* (Butler-Werner); ♂, Phoenix, July 11, 1932; ♂, Portal 4800 ft., Aug. 4, 1959 (H. E. Evans); 2♀♀, 5 mi. E. Portal, Cochise Co., Oct. 14, 1955 (C. and M. Cazier); 3♀♀, 12♂♂, 2 mi. NE. Portal, Cochise Co., 4700 ft., July 2, 1961, *Condalia lycioides* (H. A. Scullen); ♂, same locality, July 11, 1961, *Acacia greggii* (H. A. Scullen); 2♂♂, same locality, July 8, 11, 1961 (H. A. Scullen); 7♂♂, same locality, July 30, 1959, Aug. 1, 3, 1959, *Baccharis glutinosa* (M. Statham); ♀, Prescott, July 29 (J. N. Knull); 2♂♂, Sabino Canyon, Santa Catalina Mts., Pima Co., June 29, 1955, *Condalia*, *Cephalanthus* (Butler-Werner); ♂, Sedonia, June 29, 1950 (J. G. Rozen); ♂, Sedonia, June 29, 1950 (L. D. Beamer); 2♂♂, Seneca, Salt River Bridge, July 15, 1956, salt cedar (G. D. Butler); ♂, southern Arizona (Bequaert);

♂, Texas Pass, Dragoon Mts., July 19–21, 1917 (R. C. Shannon); ♂, Tombstone, July 27, 1955 (Butler-Werner); ♀, 5 mi. NW. Tombstone, Cochise Co., 4200 ft., July 25, 1937 (Rehn, Pate, Rehn); 5♂♂, Tucson (F. H. Snow); ♂, Tucson, May 7, 1957 (G. D. Butler); ♂, 9 mi. N. Tucson, July 25, 1946 (H. A. Scullen); ♂, 20 mi. NW. Tucson, July 6, 1955 (Butler-Werner); ♀, 20 mi. E. Tucson, Oct. 26, 1958 (G. and A. Ferguson); ♂, White Mts., June 19, 1950 (H. O. Wright). CALIFORNIA: ♀, Anza, Riverside Co., July 5, 1956 (R. M. Bohart); ♂, Blythe, Riverside Co., July 30, 1947, *Tamarix gallica* (J. W. MacSwain); ♂, Devils Canyon, Cochell Valley, May 7, 1932; ♂, Experimental Farm, Imperial Co., June 1912 (J. C. Bridwell); ♂, Imperial Co., May 1911 (J. C. Bridwell); ♂, Morango Valley, San Bernardino Co., Aug. 29, 1934 (C. D. Michener); ♂, Winterhaven, Imperial Co., June 16, 1956 (G. R. Ferguson). NEW MEXICO: 2♂♂, Alamogordo, July 7, 1902; ♂, 10 mi. NE. Lordsburg, June 17, 1942 (E. C. Van Dyke); ♀, Lordsburg to Silver City, 5000 ft., June 17, 1942 (H. A. Scullen); ♀, Rodeo, Hidalgo Co., July 29, 1959 (M. Statham). TEXAS: ♂, Bexar Co., May 2, 1930 (H. B. Parks); ♀, Davis Mts., Aug. 29, 1947 (D. J. and J. N. Knull); ♂, Davis Mts., July 6, 1936 (J. N. Knull); ♀, Devils River, May 3, 1907 (F. C. Bishop); ♀, El Paso, June 29, 1921 (Carl D. Duncan); ♂, Galveston, June 1900; ♀, McNary, Hudspeth Co., June 24, 1942 (H. A. Scullen). MEXICO: ♂, Las Parras, Baja, October 1923 (W. M. Mann); ♂, 20 mi. N. Mesquital, Baja, Sept. 27, 1941 (Ross and Bohart); ♂, Mulege, Baja, May 14, 1921 (E. P. Van Duzee); ♂, Nogales, Mar. 5, 1951; ♂, 10 mi. E. San Ignacio, Baja, Sept. 30, 1941 (Ross and Bohart).

DISTRIBUTION.—Southern Arizona, southern New Mexico, southwestern Texas and northern Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Acacia greggii* (Arizona), *Baccharis glutinosa* (Arizona), *Cephalanthus* sp. (Arizona), *Condalia lycioides* (Arizona), *Nolina microcarpa* (Arizona), *Prosopis juliflora* (Arizona), *Sapindus* sp. (Arizona).

31. *Cerceris compacta compacta* Cresson

FIGURES 40, 133a,b,c

Cerceris compacta Cresson, 1865, p. 127.—Packard, 1866, p. 63.—Cresson, 1872, p. 230; 1887, p. 282.—Robertson, 1887, p. 201.—Schletter, 1887, p. 488.—Robertson, 1889, pp. 297–304; 1891, pp. 570–571; 1894a, pp. 439, 455, 464; 1894b, p. 112.—Dalla Torre, 1897, p. 456.—Ashmead, 1899, p. 295.—Smith, J. B., 1900, p. 519; 1910, p. 519.—Banks, 1912a, p. 17; 1912b, p. 107.—Viereck, 1916, pp. 695, 696.—Mickel, 1917b, p. 448.—Scullen, 1951, p. 1006; 1960, p. 77.

Cerceris solidaginis Rohwer, 1908, p. 323.—Banks, 1947, p. 15.—Scullen, 1951, p. 1010.

Cerceris belfragei Banks, 1917, p. 114.—Scullen, 1951, p. 1005.

FEMALE.—Length 10 mm. Black with yellow markings, normally pitted and clothed with short silvery hairs.

Head subequal in width to thorax, black except center of face between antennal scrobes, clypeal process margin, small spots back of the eyes, and basal part of mandibles, all of which are yellow; clypeal margin extended on the medial portion, without denticles;

clypeal process lunar shaped with two oval lamellae attached to the border; mandibles with two prominent denticles, between which is a much smaller but distinct denticle; antennae normal in form with the scape yellow and remaining segments amber.

Thorax black except for a divided band on the pronotum, two large patches or a divided band on the scutellum, the metanotum, two patches on the propodeum, patch on the mesopleuron (on some), and the tegulae, all of which are yellow; enclosure ridged at a 45° angle to the base; tegulae not elevated and sparsely pitted; mesosternal tubercles absent; legs dark amber basally, becoming light amber on the femora and yellow to amber beyond; wings subhyaline, but lightly clouded along the anterior margins.

Abdomen: tergum 1 with a small yellow medial patch, tergum 2 with a broad band on the posterior half; terga 3, 4, and 5 with deeply emarginate bands quite variable in the amount of yellow; tergum 6 with a trace of yellow to the sides of the pygidium; venter dark amber; pygidium broadly rounded basally with the sides narrowing to a smaller rounded apical end.

MALE.—Length 10 mm. Black with yellow markings; normally pitted; clothed with short silvery hairs.

Head subequal to thorax in width, black except for entire face below antennal scrobes, minute spots back of eyes, basal part of mandibles, and scape, all of which are yellow; clypeal border dark amber with a very narrow extension slightly swollen in the center; hair lobes normal; clypeal surface slightly convex; mandibles with one large, acute denticle; antennae normal in form.

Thorax black except a widely divided band on the pronotum, two small patches on the scutellum, band on the metanotum, occasional patches on the propodeum, occasional patches on the mesopleuron, and the tegulae, all of which are yellow; tegulae not elevated and nearly smooth; enclosure smooth except for a deep central groove with deep pits along the lateral borders; mesosternal tubercles absent; legs very dark on the coxae, becoming amber on the femora and light amber on the tarsi; wings subhyaline becoming lightly clouded along the anterior margins.

Abdomen: tergum 1 with a small yellow patch; tergum 2 with a broad band along the posterior margin or largely covering the entire tergum; terga 3 to 6 with a more or less deeply emarginate band; venter dark amber; pygidium broadly rounded basally, tapering to a narrower rounded apical end.

Specimens of both sexes show considerable variation in the extent of the yellow markings; those from the more northern and eastern areas are inclined to be darker. Those from the southwestern areas may have considerably more yellow.

TYPES.—The type female of *C. compacta* Cresson, from Illinois, is at the Philadelphia Academy of Natural Sciences, no. 1940. The type male of *C. solidaginis* Rohwer, from Las Cruces, N. Mex., is at the U.S. National Museum, no. 28486. The type female of *C. belfragi* Banks, from Texas, is at the Museum of Comparative Zoology, Harvard, no. 10029.

DISTRIBUTION.—Throughout the eastern and central states and southwest to southern California.

PREY RECORD.—*Colaspis brunnea* (Fabricius), Chrysomelidae, Clifton, Va. (Bridwell).

PLANT RECORD.—Alfalfa (California, Arizona), *Ampelopsis arborea* (Texas), *Asclepias* sp. (New Mexico, Texas), *Asclepias verticillata* (Iowa), *Baccharis* sp. (Arizona), *Baccharis salicina* (Texas), *Bisora americana* (Texas), *Ceanothus* sp. (Virginia, North Carolina), *Chernoh americanus* (Virginia, Illinois), *Cicuta maculata* (Ohio, Virginia), cotton (Texas, Louisiana, Arizona, New Mexico), *Croton lindheimeri* (Florida), *Daucus carota* (Ohio, Texas), *Euphorbia marginata* (Kansas), *Helianthus annuus* (California), *Ligustrum* sp. (Florida), *Melilotus alba* (Ohio, Illinois, California, Utah, Arizona), parsnip (Texas), peach (Georgia), *Polytaenia nuttallii* (Texas), *Pycnanthemum* (North Carolina), *Quercus virginiana* (North Carolina), *Rhus copallina* (Florida), *Solanum elaeagnifolium* (Arizona), *Solidago* sp. (Texas, Kentucky), *Tamarix gallica* (Kansas, California, Utah).

32a. *Cerceris flavofasciata flavofasciata* H. S. Smith

FIGURES 41, 134a,b,c

Cerceris flavofasciata H. S. Smith, 1908, p. 364.—Smith, J. B., 1910, p. 678.—Mickel, 1916, p. 409; 1917b, p. 448.—Rau, 1922, p. 31.—Scullen, 1951, p. 1007.—Krombein, 1953, pp. 114, 123, 124, 125, 134; 1959, p. 197.

Cerceris natallenus Brimley, 1927, p. 238.—Scullen, 1951, p. 1007.

FEMALE.—Length 14 mm. Black with yellow markings, punctation normal, pubescence normal.

Head slightly wider than the thorax; black except for large frontal eye patches, a small patch between the antennae, and the basal part of the mandibles, all of which are yellow; clypeal border with two widely separated denticles, between which the margin is depressed slightly but otherwise smooth; clypeal process is in the form of a very broad crescent-shaped elevation equal to about seven-eighths of the distance between the eyes; on the margin of the process there is a lamellae consisting of two distinct oval membranes; mandibles with three distinct denticles, the more apical one being very large, the

basal one medium in size, and the middle one very small but very acute; antennae normal in form.

Thorax black except for a yellow band on the pronotum semidivided at the center and two small patches on the scutellum, which are amber; metanotum black; tegulae smooth, amber, and not elevated; enclosure relatively smooth except for a slight medial groove; mesosternal tubercle present but small; legs black basally, dark amber on the femora, becoming lighter amber on the apical parts; wings somewhat more clouded than in most species.

Abdomen entirely black in most specimens except for a broad yellow band on the posterior half of tergum 2; on some specimens small lateral yellow spots appear on terga 1 and 3; venter black; pygidium oval with the apical end somewhat narrowed and both ends rounded.

MALE.—Length 10 mm. Black with yellow markings; punctation and pubescence normal.

Head subequal in width to the thorax, black except large frontal eye patches, interantennal carina, variable amounts on the medial lobe of the clypeus, base of mandibles, and an evanescent spot on the scape, all of which are light yellow; clypeal extension on the medial lobe of the clypeus narrow, subequal in width to the length of the epistomal suture, and with three subequal small denticles; clypeal surface convex, mandibles with one denticle; antennae normal in form.

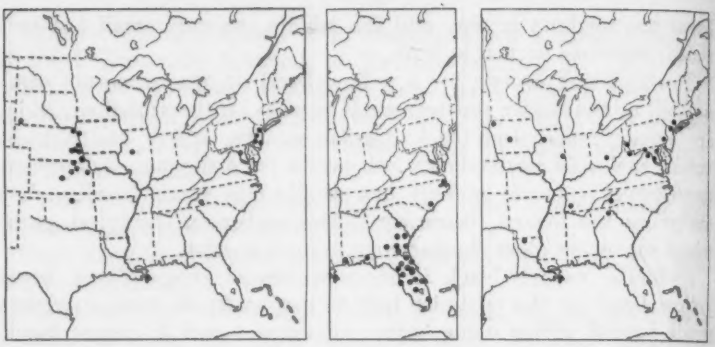
Thorax black except for a broken band on the pronotum and divided band on the scutellum; tegulae amber, smooth, and not elevated; enclosure with a light medial groove, relatively smooth but with distinct pubescence laterally; legs amber, coxae and trochanters very dark; wings somewhat clouded.

Abdomen with little or no yellow on tergum 1; a broad band on the posterior half of tergum 2; narrow yellow lines along posterior margins of terga 3 to 6; venter dark amber; pygidium oval but with the apical end truncate.

Superficially, both the female and male of *C. flavofasciata* Smith look much like *C. fumipennis* Say, but they are readily separated by the clypeal structure in each case. The female of *C. fumipennis* Say has no elevated process on the clypeus. The male of the latter has a very narrow extension on the medial lobe.

TYPES.—The type female of *C. flavofasciata* Smith is at the University of Nebraska. The type female of *C. natallenus* Brimley is at the U.S. National Museum, no. 40792.

DISTRIBUTION.—Rare through the Eastern States from South Dakota, Nebraska, and Kansas to the Atlantic Coast States; from Minnesota south to North Carolina. Specimens are as follows:



FIGURES 41–43.—Localities of: 41, *C. flavofasciata flavofasciata* H. S. Smith; 42, *C. flavofasciata floridensis* Banks; 43, *C. mandibularis* Patton.

ARKANSAS: ♀, Hot Springs, Oct. 6 (Andreas Bolter). ILLINOIS: ♀ Hanna City, July 21, 1940. IOWA: ♀, Sioux City, Aug. 10, 1917 (A. W. Lindsey). KANSAS: 3♀♀, Baldwin Co., July 8, Aug. 1, 1906 (J. C. Bridwell); ♀, Black Jack Creek, Pottawatomie Co., July 2, 1953 (Evans and party); ♀, Black Jack Creek, July 9, 1959 (H. E. and M. A. Evans); ♀, Lawrence, June 18, 1922 (C. H. Curran); ♀, Marshall Co., June 30, 1950 (R. L. Fischer); ♀, Pottawatomie Co., July 25, 1952 (H. E. Evans); 3♀♀, Riley Co., July 12, (J. B. Norton); 2♀♀, Riley Co., July 23 (Popenoe); ♀, Saline Co., July 16, 1923, (L. C. Woodruff). MINNESOTA: ♂, Lake City, July 7, 1921 (A. A. Nichol). NEBRASKA: ♀, Lincoln, July; ♂, North Bend, June 30, 1915 (E. G. Anderson). NEBRASKA: Child's Point, Lincoln, Maskell, Monroe Canyon, Omaha, Rulo, and South Bend, June 30 to Aug. 20, 1917a, on flowers of *Melilotus alba, Ceanothus americanus,* and *Amorpha canescens* (all by Mickel). NEW JERSEY: ♀, Camden, July 12, 1891 (Wm. J. Fox); 2♀♀, 5 mi. W. Lake Wood, Ocean Co., Sept. 6, 1954 (G. Ferguson); ♀, Lebanon State Forest, Burlington Co., Aug. 19, 1958 (Evans, Beneway); ♀, Lucaston, Sept. 9, 1906. NORTH CAROLINA: ♀, Bastic, July 7, 1921 (T. B. Mitchell); 15, ♀♀ 10♂♂, Kill Devil Hills, Dare Co., July 31, Aug. 1, 3, 1952, July 26, 1955, Aug. 3, 4, 7, 8, 9, 1958 (K. V. Krombein); ♂, Kill Devil Hills, Aug. 7, 1958 (T. B. Mitchell). OKLAHOMA: ♀, Pawnee Co., July 12, 1932 (Deonier, Pritchard). SOUTH DAKOTA: ♂, Hot Springs, July 12, 1924 (R. C. Severin). VIRGINIA: ♀, Camp Peary, Sept. 7, 1943 (G. E. and R. M. Bohart). MARYLAND: ♀, 30 mi. S. Washington, D.C., July 7, 1931 (J. C. Bridwell).

PREY RECORD.—*Cryptocephalus guttulatus* Oliver, *C. notatus* Fabricius, *C. notatus fulvipennis* Hald (all from Baldwin, Kansas). Krombein (1959, pp. 197–198), who studied the biology of this wasp at Kill Devil Hills, N.C., found *Cerceris flavofasciata* H. S. Smith collecting the following chrysomelids: *Chlamisus* sp. (probably *plicata* (Fabricius)), *Cryptocephalus mutabilis* Melsheimer, *Cryptocephalus guttulatus* Oliver, *Cryptocephalus* sp. (probably *quadrimaculatus* Say), *Bassareus clathratus* (Melsheimer), and *Bassareus* sp. (probably *sellatus* Suffrian).

PLANT RECORD.—*Amorpha canecens* (Nebraska), *Ceanothus americanus* (Nebraska), *Melilotus alba* (Nebraska).

32b. *Cerceris flavofasciata floridensis* Banks (new status)

FIGURE 42

Cerceris austrina Fox (male only), 1893, p. 556.—Dalla Torre, 1897, p. 453.—Ashmead, 1899, p. 296.—Scullen, 1951, p. 1005.—Krombein, 1954b, p. 235; 1956, p. 234 (new synonymy).

Cerceris floridensis Banks, 1915, p. 403.—Scullen, 1951, p. 1008.—Krombein, 1954b, p. 235.

FEMALE.—Length 12 mm. Black with ferruginous markings; punctation and pubescence average for the genus. Structurally like *C. flavofasciata flavofasciata* H. S. Smith.

Head reddish amber except for dark amber to black patches just above the antennal scrobes, the ocellar area, patches on the vertex bordering the eyes and the lower genal area, and the following parts, which are yellowish amber: large frontal eye patches, frons above the clypeal process, lateral lobes of the clypeus, and the basal part of the mandibles; apical part of mandibles and mandibular denticles dark amber; antennae ferruginous becoming dark apically.

Thorax black except the pronotum, scutellum, metanotum, most of the propodeum exclusive of the enclosure, patch on the pleuron, and the tegulae, all of which are ferruginous; legs reddish amber; wings clouded with amber.

Abdomen: tergum 1 and 2 reddish amber with a narrow yellowish line on the posterior half of tergum 2; terga 3 to 6 black with a trace of dark amber on the anterior part of tergum 3; sternites 1, 2, and 3 largely ferruginous.

MALE.—Length 10–12 mm. Black with dark ferruginous markings showing some yellowing; punctation and pubescence average; structurally like the nominate subspecies male.

Head black except for the face, which is light ferruginous medially, becoming darker on the clypeus; genae and vertex largely ferruginous; width of the clypeal extension on the medial lobe about one-half the length of the epistomal suture, with three subequal small denticles on the margin; mandibles with one prominent acute denticle; antennae normal in form.

Thorax black except for a broad band on the pronotum, scutellum, metanotum, and large patches on the propodeum, all of which are dark ferruginous; enclosure smooth except for a light medial groove; legs amber; wings clouded.

Abdomen black except for the first two segments, which are dark ferruginous with a narrow yellowish band on the apical border of the second tergum.

The males of several closely related species and subspecies in Florida and adjoining areas have been confused by earlier workers.

Only recently has the present writer been able to clear up some of this confusion. A study of type material in the British Museum, in this country, and field studies by Dr. Krombein have helped to associate correctly some of the sexes concerned. In describing *C. austrina*, Fox evidently had the two sexes wrongly associated His type female of the latter species is accepted here as the type of *austrina* Fox. The present writer here considers *C. austrina* Fox a synonym of *C. robertsonii robertsonii* Fox. The form described by him as the male of *C. austrina* Fox has been found recently by Dr. Krombein to be the male of a ferruginous color form of *C. flavofasciata* H. S. Smith. As the name *austrina* is preoccupied, this color form is given the name *C. flavofasciata floridensis* Banks. Banks described a male of this form under the name of *floridensis*.

The male of *C. rufopicta* F. Smith, which is very close to the male of *C. flavofasciata floridensis* Banks, frequently has been confused with it by the writer and other workers in earlier studies.

TYPES.—The allotype male of *C. austrina* Fox from Florida is at the Philadelphia Academy of Natural Sciences, no. 4756. The type male of *C. floridensis* Banks, from Gulfport, Florida (Reynolds), is at the Museum of Comparative Zoology, no. 13765.

DISTRIBUTION.—Southeastern States, North Carolina to Florida and west to Alabama. Specimens are as follows:

ALABAMA: ♀, Mobile, June 1949 (H. P. Loding). FLORIDA: 2♀ ♀, ♂, Cocoa, July 1944 (G. E. Bohart); ♂, Flagler Co., July 30, 1955 (H. V. Weems, Jr.); ♀, Gainesville, Alachua Co., April 16, 1952; ♀, 2♂ ♂, Gainesville, April 29, May 3, 5, 1919 (P. W. Fattig); ♀, Gainesville, May 4, 1923 (Alexander, Walker); ♂, Gainesville, May 11, 1928 (G. B. Merrill); ♂, Gainesville, May 13 (Debna, Weems); 2♂ ♂, Gainesville, Aug. 28, 1960 (P. M. Marsh); ♂, Haines City, Sept. 17, 1954 (H. V. Weems, Jr.); ♂, Hollywood, May 6, 1927 (S. Greenicher); 8♂ ♂, Inverness, 1892, 1918 (C. Robertson); ♀, Jacksonville, Oct. 6–9, 1941 (Howard E. Evans); ♀, ♂, Lake Placid, Archbold Biological Station, March 28, 29, 1957 (H. E. Evans); 4♂ ♂, Lake Placid, April 1, 1954, June 22, 25, 28, 1962 (K. V. Krombein); ♂, Levy Co., July 13, 1954 (H. V. Weems, Jr.); ♀, Newman's Lake, Alachua Co., Sept. 4–6, 1929 (T. H. Hubbell); 2♀ ♀, Orlando, March (R. and G. Bohart); ♂, Orlando, April 11, 1925 (O. C. McBride); ♀, Ponce de Leon, July 13, 1934 (M. E. Griffith); ♂, Sanford, May 2, 1955 (H. E. and M. A. Evans); ♂, Silver Springs, July 28, 1962 (F. Jacot-Guillarmod); ♀, Tutusville, April 25, 1923; ♂, Wagner, April 10, 1941 (H. T. Fernald); ♂, Winter Park, May 27, 1942 (H. T. Fernald); ♀, "Florida." GEORGIA: ♂, Augusta, Richmond Co., May 30, 1959 (R. R. Snelling); ♀, Groveland, Cannoche River, July 28, 1913 (J. C. Bradley); 3♀ ♀, ♂, "N. Georgia"; 2♀ ♀, Okefenokee Swamp, July 10, 1934, July 27, 1939 (R. H. Beamer); ♀, Spring Creek, Decatur Co., Aug. 10, 1946 (P. W. Fattig); ♂, St. Simons Island, May 13, 1932 (P. W. Fattig); 2♂ ♂, Tifton, May 30, 1946; 3♀ ♀, Videlia, Aug. 29, 31, 1937, Aug. 20, 1946 (P. W. Fattig); ♀, Waycross, July 16, 1916. NORTH CAROLINA: ♀, Burgaw, Aug. 19, 1948 (T. B. Mitchell); ♂, Kill Devil Hills, June 30, 1950 (K. V. Krombein)

PREY RECORDS.—None.

PLANT RECORDS.—*Ceanothus americanus* (New Jersey Tea), *Ilex opaca*, mango trees, avocado (Florida).

33. *Cerceris mandibularis* Patton

FIGURES 43, 135a,b,c

Cerceris mandibularis Patton, 1880, p. 403.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 496.—Dalla Torre, 1897, p. 467.—Ashmead, 1899, p. 295.—Banks, 1912, p. 17.—Mickel, 1918, p. 447.—Cartwright, 1931, pp. 269–270.—Scullen, 1951, p. 1009.

FEMALE.—Length 11 mm. Black with yellow markings, punctation somewhat widely separated and shallow, pubescence short and silvery.

Head subequal in width to the thorax; black except for most of the face below the antennal scrobes, base of mandibles, and scape, all of which are yellow; lower clypeal area and margin dark amber; margin of medial lobe slightly extended with two lateral denticles, between which is a broad extension; clypeal process broad and lunar shaped with a short but broad uniform lamination attached to the margin; mandibles with a broad expansion on the inner edge, the margin of which shows three indistinct denticles; antennae normal in form.

Thorax black except for two widely separated narrow patches on the prothorax, two small patches on the scutellum, and the tegulae, all of which are yellow; tegulae smooth and not elevated; enclosure with a central groove and ridged at a 45° angle; mesosternal tubercles absent; legs dark basally, gradually becoming light amber to yellow apically; wings subhyaline.

Abdomen: tergum 1 with a small divided patch of yellow; tergum 2 with a broad deeply emarginate band on the posterior half; terga 3, 4, and 5 with narrow emarginate bands on the posterior margin; tergum 6 black; venter black; pygidium oval with the apical part somewhat narrowed and both ends rounded.

MALE.—Unknown.

TYPE.—As the original type of *Cerceris mandibularis* Patton has apparently been lost, a neotype has been designated. Taken at Glenside, Pa., July 5, 1905 (G. M. Green), it is deposited at the U.S. National Museum.

The neotype selected is 2 mm. longer than the indicated length in the original description of the species and has more yellow. Structurally it agrees with the original description and is representative of the species as recognized by later workers (Cresson and Banks). The male has never been identified. It is doubtless close to the males of related species, with which it probably has been confused. The female of *mandibularis* Patton closely resembles such related species as

robertsonii Fox but the clypeal processes and their lamellae easily separate them.

DISTRIBUTION.—This species has been taken mostly in the Eastern States from New York south to Georgia and west to Iowa. Even though widely distributed in the East, collection records are relatively few. The following specimens have been recorded by the writer:

ALABAMA: ♀, Kushla. DISTRICT OF COLUMBIA: ♀, Washington, June 22, 1951 (N. Banks). GEORGIA: ♀, Tallulah Falls, June 19–25, 1909 (J. C. Bradley). ILLINOIS: ♀, Danville, August 31, 1924 (A.S.B.); ♀, Prophetstown, July 7, 1925 (T. H. Frison). IOWA: ♀, Ledges State Park, Boone Co., July 29, 1950 (Jean LaFoon); ♀, Lyon Co., July 7, 1936 (H. E. Jaques); 2 ♀♀, Lyon Co., July 7, 1936 (D. Milspaugh). LOUISIANA: ♀, Claiborne Co., May 22, 1931. MARYLAND: ♀, Baltimore, July 1914 (F. E. Blaisdell); ♀, Baltimore, July 1909; ♀, Thomas Road, near Cumberland, June 28, 1953 (L. M. Walker). NEW JERSEY: ♀, Riverdale, July 24, 1909 (L. B. Woodruff). NEW YORK: ♀, Bohemia, June 20, 1937 (K. V. Krombein); ♀, White Plains, June 29, 1918 (J. Bequaert). NORTH CAROLINA: ♀, Mars Hill, July 6, 1928 (J. B. Mitchell). OHIO: ♀, Hocking Co., May 20 (D. J. and J. N. Knull); ♀, S. Bloomingville, July 2, 1946 (U. N. Lanham). PENNSYLVANIA: ♀, Glenside, July 5, 1909 (G. M. Greene); ♀, Leighgap, July 1, 1897; ♀, Pittsburg, June 15, 1911 (Hugo Kahl). TENNESSEE: ♀, Tennessee City. VIRGINIA: ♀, Dunn Loring, July 28, 1951 (K. V. Krombein); 3 ♀♀, Falls Church, June 7, 27, July 6 (N. Banks). WEST VIRGINIA: ♀, Monongalia Co., June.

PREY RECORD.—The only information available relative to the prey collected by *Cerceris mandibularis* Patton is reported by Cartwright (1931, p. 269), who reports the wasps collecting a grasshopper nymph. This recorded observation is open to question unless verified by later reports.

PLANT RECORD.—None.

34a. *Cerceris robertsonii robertsonii* Fox

FIGURES 44, 136a,b,c

Cerceris robertsonii Fox, 1893 p. 55.—Robertson, 1894a, p. 464; 1894b, p. 112.—Ashmead, 1899, p. 296.—Smith, J. B., 1900, p. 519; 1910, p. 678.—Banks, 1912a, p. 17; 1912b, p. 107.—Viereck, 1916, p. 695.—Britton, 1920, p. 342.—Krombein, 1949, p. 271; 1950, p. 148.—Scullen, 1951, p. 1010.—Krombein, 1952c, pp. 288–295; 1952b, p. 95; 1953, pp. 119–121, 122, 123; 1954b, p. 235; 1955, p. 234.—Linsley and MacSwain, 1956, pp. 77, 79.—Evans, 1957, p. 86, pl. 12.—Krombein, 1958a, p. 197.—Evans, 1959, pp. 156–7.

Cerceris austrina Fox (female only),[12] 1893, p. 556.—Dalla Torre, 1897, p. 453.—Ashmead, 1899, p. 296.—Scullen, 1951, p. 1005.—Krombein, 1954b, p. 235; 1956, p. 234 (new synonymy).

Cerceris pleuralis H. S. Smith, 1908, p. 366.—Mickel, 1918, p. 452.

FEMALE.—Length 12 to 13 mm. Black with yellow markings; punctation average; pubescence short.

[12] For a discussion of this species, see under *C. f. floridensis* Banks (p. 424).

Head subequal in width to the thorax; black except most of the face, a small patch back of the eye, base of the mandible, and a patch on the scape, all of which are yellow; clypeal border with four extensions, the medial two in the form of rounded carina and the two lateral ones denticle-like; the clypeal surface elevation broad, uniformally convex, and with a lamella on the free margin, the lamella more or less emarginate but not divided; mandibles with three denticles, the most apical one the largest and pointing apically; antennae normal in form.

Thorax black except for a divided band on the pronotum, two oval patches on the scutellum, small spot on the pleuron, and spot on the tegulae, all of which are yellow; tegulae low and smooth; enclosure with a light medial groove and light ridges at about a 45° angle to the base; mesosternal tubercle small; legs yellow to fulvous with a darker area on the base of the femora and on the two basal segments.

Abdomen with terga 1 and 6 immaculate, tergum 2 with a broad band on the posterior half, terga 3, 4, and 5 with narrow bands deeply emarginate; venter immaculate; pygidium oval with the apical end the narrower.

MALE.—Length 10 to 11 mm. Black with yellow markings; punctation average; pubescence short.

Head subequal in width to the thorax; black except for the entire face, basal half of mandibles, and the scape, all of which are yellow; extension on the medial lobe of the clypeus narrow with three indistinct denticles; clypeal surface convex; hair lobes very narrow, less than the width of the lateral clypeal lobes; lateral clypeal lobes covered with prominent setae; mandibles with one small acute medial denticle; antennae with the apical segment slightly curved.

Thorax black except for a divided band on the pronotum; a semidivided band on the scutellum, spot on the pleuron, and a spot on the tegulae, all of which are yellow; tegulae low and smooth; enclosure without the usual medial groove, somewhat punctate laterally and lightly rugose along the anterior margin; mesosternal tubercle absent; fore- and midlegs with the first two segments black and yellow, the femora very dark basally, becoming light apically, remaining segments yellow; hindlegs with the coxae black and yellow, trochanters yellow, femora black basally, and the remaining segments largely amber with darker areas; wings subhyaline but clouded.

Abdomen with terga 1 and 7 immaculate, tergum 2 with a broad band on the posterior half; terga 3 to 6 with narrow emarginate bands; venter with traces of yellow laterally on sternites 2, 3, and 4; pygidium with convex sides converging to a truncate apical end.

Superficially, *C. robertsonii robertsonii* Fox closely resembles *C. clypeata* Dahlbom, *C. atramontensis* Banks, and other related forms in

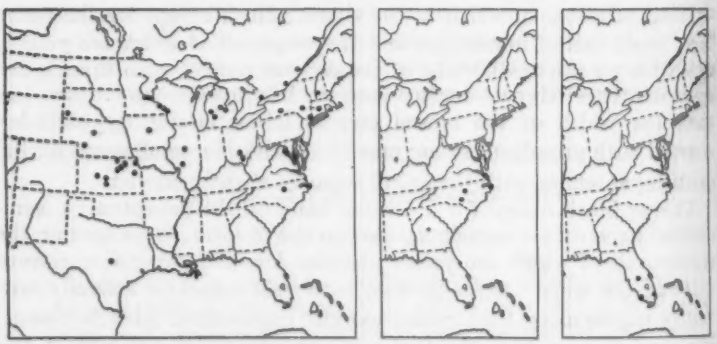
size and coloring, but the females can be separated easily by the form of the clypeal process, and the males, by the extension on the medial clypeal lobe.

TYPES.—The type female of *C. robertsonii* Fox, from Smithville, S. Dak. (J. T. Aldrich), is at the Philadelphia Academy of Natural Sciences, no. 4755. The type female of *C. austrina* Fox, from southern Florida, is at the Philadelphia Academy of Natural Sciences, no. 4756. The type female, from Rock Co., Nebr., July 22, 1902, on *Helianthus* sp. (W. D. Pierce), and the allotype male, from Glen, Sioux Co., Nebr., 4000 ft., Aug. 19, 1906 (P. R. Jones), of *C. pleuralis* H. S. Smith, are at the University of Nebraska.

DISTRIBUTION.—Throughout the Eastern States, from Nebraska and Kansas east to the Atlantic States and from southern Canada south to North Carolina, with one record from Texas.

PREY RECORD.—*Rhabdopterus picipes* (Oliver), *Cryptocephalus notatus* Fabricius, *Pachybrachys dilatatus* Suffrian. All are chrysomelids, reported by Krombein (1953) from North Carolina.

PLANT RECORD.—*Melilotus alba* (Kansas), parsnip (Minnesota), *Quercus marilandica* (North Carolina), *Q. virginiana* (North Carolina), *Liquidambar styraciflua* (North Carolina).



FIGURES 44–46.—Localities of: 44, *C. robertsonii robertsonii* Fox; 45, *C. robertsonii bifidus* Scullen; 46, *C. robertsonii emmiltorus* Scullen.

34b. *Cerceris robertsonii bifidus*, new subspecies

FIGURES 45, 137a,b,c

FEMALE.—Length 12 mm. Black with yellow and ferruginous markings; structurally like the nominate subspecies *C. robertsonii robertsonii* Fox except as indicated below.

Head as in the nominate subspecies except that the clypeal lamella is divided completely to the base.

Thorax like the nominate subspecies except that the yellow patches on the scutellum are fused lightly at the meson and the yellow markings on the legs replaced largely by ferruginous.

Abdomen shows no important differences from the nominate subspecies.

MALE.—Unknown.

TYPES.—The type female, from Kill Devil Hills, N. C., Aug. 4, 1952 (K. V. Krombein), is at the U.S. National Museum, no. 66165. Paratypes are as follows:

GEORGIA: ♀, Head River, July 24, 1936 (P. W. Fattig). INDIANA: ♀, Mineral Springs, July 29, 1923 (Owen Bryant). NORTH CAROLINA: ♀, Aberdeen, July 16, 1951 (Beamer, Weed, Price); 5 ♀ ♀, Kill Devil Hills, June 27, July 1, 11, 14, 1950, Aug. 3, 1952 (K. V. Krombein); ♀, Raleigh, July 23, 1924 (C. S. Brimley). VIRGINIA: ♀, Princess Anne Co., Aug. 1, 1928.

PREY RECORD.—None.

PLANT RECORD.—None.

34c. *Cerceris robertsonii emmiltosus* Scullen

FIGURE 46

Cerceris robertsonii emmiltosus Scullen, 1964, p. 144.

This subspecies is very similar to *C. robertsonii miltosus* except for the form of the lamella on the clypeal process. The lamella of *emmiltosus* has little or no emargination and is never completely divided at the meson as *miltosus*. Both subspecies are found in the Florida area.

TYPE.—The type female of *C. robertsonii emmiltosus* Scullen, from Miami, Fla., March 29–30, 1953 (K. V. Krombein), is at the U.S. National Museum, no. 66166.

DISTRIBUTION.—Florida and Georgia.

PREY RECORD.—None.

PLANT RECORD.—None.

34d. *Cerceris robertsonii miltosus*, new subspecies

FIGURE 47

FEMALE.—Length 11 mm. Black with yellow and ferruginous markings; structurally like the nominate subspecies except as indicated below.

Head black except the face, basal two-thirds of the mandibles, and the scape, all of which are yellow; clypeal lamella divided medially to the base.

Thorax black except the entire pronotum, scutellum, metanotum, and the tegulae, all of which are ferruginous; legs ferruginous, becoming more yellowish apically, wings clouded.

Abdomen with tergum 1 ferruginous, tergum 2 ferruginous except for a broad black area anteriorly, tergum 3 with a narrow band, which becomes broad laterally, tergum 4 with a broken line posteriorly, tergum 5 with lateral patches only; all abdominal markings become progressively more yellow posteriorly.

MALE.—Unknown (See note under *C. f. floridensis* Banks, p. 424).

This subspecies is very similar to *C. robertsonii emmiltosus* Scullen, from which it may be distinguished by the form of the clypeal lamella.

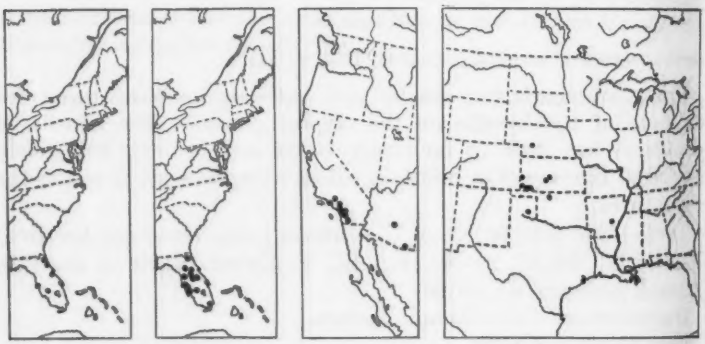
TYPE.—The type female, from Arcadia, Fla., April 23, 1953, on sand (K. V. Krombein), is at the U.S. National Museum, no. 66167. Paratypes are as follows:

FLORIDA: ♀, Augustine; ♀, Cocoa, June 1944 (G. E. Bohart); ♀, Jacksonville; ♀, St. Petersburg, July 1957 (G. Heinrich).

DISTRIBUTION.—Florida.

PREY RECORD.—None.

PLANT RECORD.—None.



FIGURES 47–50.—Localities of: 47, *C. robertsonii miltosus* Scullen; 48, *C. rufopicta* F. Smith; 49, *C. sandiegensis* Scullen; 50, *C. squamulifera* Mickel.

35. *Cerceris rufopicta* F. Smith

FIGURES 48, 138

Cerceris rufo-picta Smith, F., 1856, p. 467.—Cresson, 1865, p. 131.—Packard, 1866, p. 61.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 501.—Dalla Torre, 1897, p. 471.—Ashmead, 1899, p. 295.—Scullen, 1951, p. 1010.

FEMALE.—Unknown.

MALE.—Length 10 mm. Black with yellow and ferruginous markings; punctuation and pubescence average.

Head subequal in width to the thorax; black except the entire face, basal two-thirds of mandibles, and a patch on the scape, all of which are yellow clouded with amber; extension of the medial clypeal lobe subequal in width to the length of the epistomal suture, with three low denticles; medial clypeal lobe convex; hair lobes narrow, covering slightly over half the lateral clypeal lobes; mandibles with one small denticle; antennae normal in form; flagellum ferruginous basally, becoming dark fuscous apically.

Thorax black except for the entire pronotum, the scutellum, metanotum, tegulae, and patches on the propodeum, all of which are ferruginous; tegulae low and smooth; enclosure rugose with a deep medial groove and coarsely pitted laterally; mesosternal tubercle absent; legs ferruginous; wings subhyaline but clouded.

Abdomen with the two anterior terga ferruginous with a yellowish line along the posterior border of tergum 2, terga 3 to 7 black with evanescent ferruginous lines along posterior margins of terga 3 and 4, becoming broader laterally, trace of ferruginous laterally on tergum 5; venter black except the two anterior sternites, which are ferruginous, and a trace of ferruginous laterally on sternite 3; pygidium with sides convex and with ends subequal in width.

For a discussion on the identification of the male of *C. rufopicta*, see note under *C. flavofasciata floridensis* Banks (p. 424). *C. rufopicta* F. Smith may prove to be the male of *C. robertsonii emmiltosus* Scullen or *C. robertsonii miltosus* Scullen.

DISTRIBUTION.—Florida and adjoining states north to North Carolina. Specimens are as follows:

FLORIDA: ♂, Arcadia, May 11, 1961 (H. E. Evans); ♂, Gainsville, May 24, 1928 (G. B. Merrill); ♂, Gainesville, May 17, 1959 (H. V. Weems, Jr.); ♂, Hillsboro Co., April 5, 1930 (C. L. Rabb); 40 ♂♂, Inverness, 1892 (Robertson); 2♂♂, Nov. 5 (Andreas Bolter); 2♂♂, Juniper Springs, Marion Co., May 12–14, 1954 (Karl V. Krombein); ♂, Key Largo, April 27, 1946 (N. Mason); 26 ♂♂, April 1, 1954, June 22, 26, 1962 (Karl V. Krombein); 2♂♂, Lake Placid, Archbold Biological Station, April 15, 1947 (J. G. Needham); ♂, same locality, April 6, 1956 (H. V. Weems, Jr.); 8♂♂, same locality, March 17, 25, April 1, 2, 7, 1961 (S. W. Frost); ♂, same locality, May 28, 1961 (H. E. and M. A. Evans); ♂, Miami, (P. W. Popenoe); ♂, Miami, April 13, 1944 (D. C. Denning); ♂, 10 mi. SW. Ocala, Sept. 2, 1938 (Hubbell-Friauf); ♂, Orange Co., April 12, 1930 (N. W. Knowles); ♂, Orlando, March 1944 (R. and G. Bohart); 4♂♂, Sanford, May 2, 1955 (H. E. and M. A. Evans); ♂, Tampa; ♂, Wagner, April 10, 1941 (H. T. Fernald); ♂, Welake, April 18–20, 1955 (H. E. and M. A. Evans); ♂, Winter Park, April 29, 1936. GEORGIA: 2♂♂, "Georgia" (Cresson); ♂, "Georgia" (Morrison); 4♂♂, "Georgia"; ♂, "Georgia," February 1877.

PREY RECORDS.—None.

PLANT RECORDS.—*Ceanothus americanus* (New Jersey Tea), avocado (Florida).

36. *Cerceris sandiegensis*, new species

FIGURE 49

FEMALE.—Length 14 mm. Black with yellow markings; very little amber; punctation and pubescence normal; structurally near the female of *C. compacta compacta* Cresson except it averages slightly longer and more slender. Enclosure somewhat smoother.

Head black except face below antennal scrobies, two spots on the vertex, patch back of the compound eye, basal two-thirds of mandibles, and scape, all of which are yellow; apical third and denticles of mandibles very dark; peduncle and basal segments of flagellum amber, apical segments darker.

Thorax black except band on pronotum, scutellum, narrow patch on metanotum, patch on the propodeum, tegulae, and spot on the pleuron, all of which are yellow; legs largely yellow with the femora becoming amber to dark amber dorsally; wings subhyaline with a more clouded area along the anterior part.

Abdomen almost entirely yellow except anterior part of terga 1 and 2, sternite 1, and anterior part of sternite 2, all of which are very dark amber to black.

Many females have the patch on the propodeum C-shaped and some are intermediate.

MALE.—Length 12 mm. Black with yellow markings; punctation and pubescence normal; structurally near the male of *C. compacta compacta* Cresson except it averages slightly larger; enclosure somewhat smoother.

Head black except for the face, two small spots back of the eyes, anterior two-thirds of mandibles, and scape, all of which are yellow; apical third of mandibles very dark; antennae beyond scape amber for the first 2 or 3 segments, gradually changing to a very dark amber.

Thorax black except for a broken band on the pronotum, two small patches on the scutellum, patch on the propodeum, small patch on the pleuron, and the tegulae, all of which are yellow; enclosure relatively smooth; legs black and yellow; posterior trochanter largely yellow; all femora mostly dark amber to black; tibiae and tarsi mostly yellow, becoming amber on the apical tarsal segments; wings subhyaline with a more clouded area along the anterior part.

Abdomen almost entirely yellow except the anterior part of terga 1 and 2, sternite 1, and anterior part of sternite 2, all of which are dark amber to black.

TYPES.—The type female, from two miles east of Anza, Riverside Co., Calif., July 14, 1956, on *Croton californica* (M. Wasbauer), and allotype male, Idyllwild, Riverside Co., Calif., June 27, 1956, on

Eriogonum fasciculatum var. *polifolium* (M. Wasbauer), both deposited at the California Academy of Sciences. Paratypes are as follows:

ARIZONA: ♂, Hereford, Cochise Co. (W. M. Mann); ♂, Tempe, Aug. 4, 1917. CALIFORNIA: ♀, ♂, Anza, Riverside Co., July 3, 1956 (L. A. Stange); ♀, Anza, July 7, 1956, *Eriogonum fasciculatum* var. *polifolium* (E. G. Linsley); ♀, Anza, July 14, 1956 (M. Wasbauer); 2 ♂♂, 4 mi. N. Cajon, San Bernardino Co., June 17, 1956 (G. R. Ferguson); 2 ♂♂, 4 mi. N. Cajon Junction, San Bernardino Co., July 14, 1958 (E. I. Schlinger); ♂, same locality, July 1, 1958 (J. C. Hall); ♂, Cajon Pass, San Bernardino Co., June 24, 1949 (H. E. Scott); ♂, Cajon Pass, July 19, 1956 (H. R. Moffitt); ♂, Cuyamaca, July 17, 1949 (D. J. and J. N. Knull); ♀, Groveland, Aug. 20, 1953 (R. H. Goodwin); ♂, Idyllwild, San Jacinto Mts., June 17, 1940 (E. C. Van Dyke); ♂, Idyllwild, Aug. 3, 1935 (Jean Russell); ♀, ♂, Idyllwild, June 19, 1951 (G. C. Bechtel); ♂, Idyllwild, June 27, 1956, *Eriogonum fasciculatum* var. *polifolium* (M. Wasbauer); ♂, Jacomba, June 19, 1954 (D. J. and J. N. Knull); 3♂♂, Los Angeles (Coquillett); ♂, Los Angeles, June 22, 1926 (Chas. H. Hicks); ♂, Newton, July 14, 1949 (D. J. and J. N. Knull); ♀, ♂, Oak Glen Lodge, San Bernardino Co., 5000 ft., July; ♀, 4♂♂, Oak Grove, San Diego Co., June 6, 1940 (C. D. Michener); 9♀♀, 12♂♂, Pine Valley, San Diego Co., Aug. 2, 1926, Aug. 1, June 27, 1927 (F. W. Kelsey); ♂, Riverside, May 15, 1925 (Timberlake); 3♂♂, Riverside, May 27 and June 1, 1954 (J. C. Hall); 2♀♀, 7♂♂, San Jacinto Mts., July 1912, July 14, 1912 (J. C. Bridwell); ♂, San Jacinto Mts., Herkey Creek, June 20, 1940 (Fred H. Rindge); ♀, Tanbark Flat, Los Angeles Co., July 7, 1950 (H. F. Robinson); ♀, Temecula, Riverside Co., July 4, 1950 (J. W. MacSwain); ♂, Warner Springs, San Diego Co., July 8, 1956, *Eriogonum fasciculatum* var. *polifolium* (P. D. Hurd); 2♂♂, Warner Springs, Aug. 8, 1957, June 12, 1958 (H. R. Moffitt); ♂, Warner Springs, July 4, 1956 (R. W. Bushing); ♂, Warner Springs, June 12, 1958 (J. C. Hall); ♂, Warner Springs, July 4, 1956 (R. M. Bohart); ♂, 9 mi. S. Warner Springs, July 4, 1956 (R. M. Bohart); ♂, Wrightwood, San Bernardino Co., 5500 ft., July 1, 1956 (L. A. Stange); ♂, Wrightwood, June 1, 1950 (H. R. Moffitt); ♀, Yucaipa, San Bernardino Co., June 25, 1952 (L. D. Beamer and party). NEW MEXICO: ♂, Taos Co., June 14, 1956 (R. and K. Dreisbach).

DISTRIBUTION.—Southern California, southern Arizona, and southwestern New Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Croton californica* (California), *Eriogonum fasciculatum* var. *polifolium* (California).

37. *Cerceris squamulifera* Mickel

FIGURES 50, 139a,b,c

Cerceris squamulifera Mickel, 1916, p. 411; 1917b, p. 451.—Scullen, 1951, p. 1010.

FEMALE.—Length 10 mm. Black with yellow and amber markings; normal punctation, normal pubescence.

Head subequal in width to the thorax; black except for the face below the antennal scrobes, large patches back of the compound eyes, the basal two-thirds of the mandibles, and the scape, all of which are yellow; clypeal border slightly extended on the medial

lobe sinuate but without distinct denticles; clypeal process low and with the free margin equal to about one-third of the distance between the eyes; the clypeal lamellae not divided but slightly emarginate on the free margin and bent to about a 45° angle from the plane of the process surface; mandibles with three denticles, the more apical one very large, the medial one very small, and basal ones medium in size; antennae normal in form.

Thorax black except for a broad band on the pronotum, the scutellum, a narrow patch on the metanotum, a large comma-shaped area on the propodeum, and the tegulae, all of which are yellow; tegulae smooth and not elevated; enclosure smooth except for minute punctation and marginal deep pits; legs largely light amber, becoming yellow on the more apical parts of the first and second pair; wings subhyaline.

Abdomen largely yellow; first and second terga with the anterior one-third amber and posterior two-thirds yellow; terga 3, 4, and 5 with broad yellow bands slightly emarginate, with black anteriorly; tergum 6 very dark amber; venter amber except for lateral yellow patches on sternites 3 and 4; pygidium oval, narrowing apically.

MALE.—Unknown.

This species is very close to *C. robertsonii* Fox, but they can be separated easily by the form of the clypeal process.

TYPE.—The type female of *C. squamulifera* Mickel from Imperial, Nebr., is at the University of Nebraska.

DISTRIBUTION.—Through the Western-Central States, from Nebraska south through Kansas, Arkansas, Oklahoma, and into Texas. Specimens are as follows:

ARKANSAS: ♀, Arkansas River, June 8, 1956 (H. E. Evans, E. G. Matthews). KANSAS: 3 ♀♀, Hamilton Co. (F. H. Snow); ♀, Meade Co., August 14, 1945 (R. H. Beamer); 2 ♀♀, Medora, July 7, 1953 (Evans, Lin and Vashimoto); ♀, Morton Co., (F. H. Snow); ♀, Seward Co., August 16, 1911 (F. X. Williams); ♀, Stafford Co., June 30, 1934 (R. H. Painter). NEBRASKA: 3 ♀♀, Wallace Co., July 7, 1931, July 2, 3, 1933 (R. Roberts). NORTH CAROLINA: ♀, Southern Pines, June 13, 1918. OKLAHOMA: ♀, Alfalfa Co., August 8, 1932 (C. C. Dennier). TEXAS: ♀, Clarendon Co., August 11, 1905 (Hunter); ♀, Cypress Mills; ♀, Galveston, Galveston Co.; ♀, Galveston, May (F. H. Snow); ♀, Galveston, June 24, 1924 (Trotter); 3 ♀♀, Galveston, June 1900.

PREY RECORD.—None.

PLANT RECORD.—None.

Group IV

This group is distinguished by the following characters: (1) The females have a prominent cone-shaped process on the medial clypeal lobe, which is flanked on each side by a much smaller process attached to the lateral clypeal lobe. (2) The males have the medial denticle

on the clypeal margin bicuspidate. (3) The pygidium of the male is very broad, almost oval. (4) The hair lobes of the male are very broad, almost meeting medially. (5) Tenebrionidae are used as prey by both species.

38a. *Cerceris femurrubrum femurrubrum* Viereck and Cockerell

FIGURES 51, 53, 140a,b,c,d,e,f

Cerceris femurrubrum Viereck and Cockerell, 1904, p. 135.—Viereck, 1906b, p. 234.—Mickel, 1917b, p. 451.—Banks, 1947, p. 15.—Scullen, 1951, p. 1007; 1960, p. 78.

Cerceris thione Banks, 1947, pp. 18–19.—Scullen, 1951, p. 1007.

FEMALE.—Length 12 mm. Amber with light yellow markings, very little black; structurally like *C. femurrubrum athene* Banks in all respects, except for color.

Head all but totally amber except for a variable amount of yellow on the face mesad of the eyes.

Thorax all amber to dark amber except for variable amounts of yellow on the prothorax, the scutellum, the metanotum, the propodeum, and the pleuron.

Abdomen amber with subequal emarginate bands on the terga along the posterior margins, all of which are yellow; venter amber.

MALE.—Length 11 mm. Black with creamy-white markings and some amber parts; punctation and pubescence average.

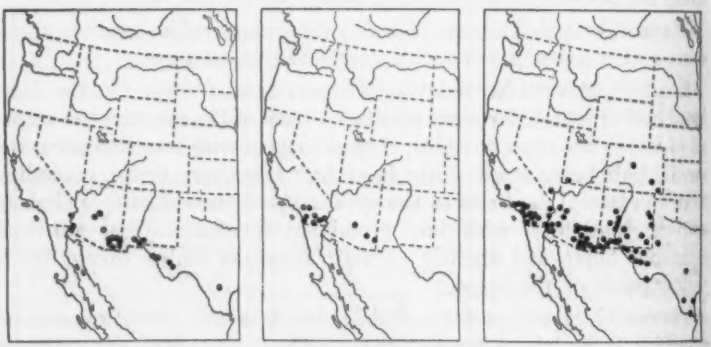
Head slightly wider than the thorax; black except for the face, basal half of mandibles, very small spot back of the eye, and the scape, all of which are creamy white; clypeal margin with four denticles, the medial pair being fused at the base; hair lobes very broad, extending from the lateral denticles to the eyes; clypeal process surface slightly convex; mandibles with one prominent denticle; apical antennal segments blunt and slightly curved; antennae amber except for a yellow patch on the scape.

Thorax black except for a divided band on the pronotum and an emarginate or divided band on the scutellum, an evanescent patch on the metanotum, patches on the propodeum, patch on the pleuron, and the tegulae, all of which are creamy white; tegulae low and smooth; enclosure smooth except for a prominent medial groove and lateral pits; mesosternal tubercles absent; legs variable in color, forelegs light to dark amber basally to the apical part of femora, beyond which they are creamy white; midlegs largely creamy white except most of the femora, which are light to dark amber; hindlegs light to dark amber except the coxae, trochanter, basal part of tibae, and most of the tarsi, all of which are creamy white; wings subhyaline, slightly clouded toward the apex.

Abdomen black with subequal creamy-white bands covering about one-third of each tergum; venter black with creamy-white spots laterally on 3rd, 4th, and 5th sternites; pygidium oval with the apical end truncate.

C. femurrubrum Viereck and Cockerell is very different from all other species but in several structural characters is close to *C. macrosticta* Viereck and Cockerell. Both species have been known to use Tenebrionidae as prey for their young.

The males of *C. femurrubrum* Viereck and Cockerell show little variation in color throughout the range of the species; however, the females show two distinct color forms, which are recognized here as separate subspecies. The reddish form has been found only from the Colorado River area east. Since the type male of *C. femurrubrum* Viereck and Cockerell is from Albuquerque, N. Mex., this reddish form of female is placed under the subspecies *femurrubrum femurrubrum* Viereck and Cockerell. The black and yellow form of female is taken almost exclusively in southern California. This is the color form of the female described as *C. athene* Banks from Claremont, California. This is placed under the subspecies *C. femurrubrum athene* Banks.



FIGURES 51–53.—Localities of: 51, *C. femurrubrum femurrubrum* Viereck and Cockerell (females only); 52, *C. femurrubrum athene* Banks (females only); 53, *C. femurrubrum* Viereck and Cockerell (males only).

TYPES.—The type male of *C. femurrubrum* Viereck and Cockerell, from Albuquerque, N. Mex., June 30 (Cockerell), is at the Philadelphia Academy of Natural Sciences, no. 10040. The type male of *C. thione* Banks, from Colton, Calif. (Pilate), is at the Museum of Comparative Zoology, Harvard, no. 23593.

DISTRIBUTION.—Southern Nevada, southern Utah, southern Colo-

rado, and south into Arizona, New Mexico, and southwestern Texas.

PREY RECORDS.—None.

PLANT RECORDS.—*Acacia* sp. (Arizona), *A. augustissima* (Arizona), alfalfa (Arizona), *Aplopappus* sp. (Arizona), *Asclepias* sp. (New Mexico), *A. subverticillata* (Arizona), *Baccharis* sp. (Arizona), *B. glutinosa* (Arizona), *Cissus trifoliata* (Arizona), *Cleome* sp. (Arizona), cotton (Arizona), *Croton* sp. (Arizona, New Mexico), *Dondia nigra* (Nevada), *Eriogonum* sp. (Arizona, New Mexico), *E. abertianum neomexicanum* (Arizona), *E. thomasii* (Arizona), *Gutierrezia* sp. (Arizona), *Haplopappus hartwegi* (Arizona), *Helianthus* sp. (Arizona), *Lepidium* sp. (Arizona), *Melilotus alba* (Arizona), *Mimosa* sp. (Arizona), pigweed leaves (Arizona), *Sapindus saponari* (Arizona), *Wislizenia* sp. (Arizona), *W. refracta* (Arizona).

38b. *Cerceris femurrubrum athene* Banks, new status

FIGURE 52

Cerceris athene Banks, 1947, pp. 20–21.—Scullen, 1951, p. 1005.—Wasbauer, 1957, p. 131.—Scullen, 1960, p. 78.

FEMALE.—Length 12 mm. Black, yellow, and amber; punctation small and somewhat sparse; pubescence average.

Head slightly wider than the thorax; black except for large frontal eye patches on the face, small spots on the lateral clypeal lobes, two elongate patches on the vertex, small round patches back of the eye, and base of mandibles, all of which are yellow; most of the clypeus and most of the mandibles are dark amber; clypeal margin with a broad extension on the medial lobe flanked by a distinct denticle on each side and laterad of each of these denticles is another separate and much larger denticle; a cone-shaped process on the surface of the medial lobe of the clypeus pointing ventrad; mandibles with a single basal denticles, apicad of which is a prominent ridge; antennae normal in form, amber, becoming darker apically.

Thorax black except for an emarginate band on the prothorax, the scutellum, the metanotum, very large areas on the propodeum, a patch on the pleuron, and the tegulae, all of which are yellow; tegulae are low and smooth; enclosure smooth except for a faint medial groove and small pits along the lateral sides; mesosternal tubercles absent; legs largely amber; wings subhyaline but somewhat clouded toward the apex.

Abdomen: all terga yellow emarginate with black anteriorly; venter dark amber; pygidium with sides convex, slightly converging apically and the apical end truncate.

MALE.—Indistinguishable from the male of *femurrubrum femurrubrum* Viereck and Cockerell.

TYPES.—The type female of *C. athene* Banks, from Claremont, Calif. (C. F. Baker), is at the Museum of Comparative Zoology, Harvard, no. 23537.

DISTRIBUTION.—Southern California, with a few scattered records east of the Colorado River in Arizona, New Mexico, and Texas.

PREY RECORD.—*Eurymetopon rufipes* Escholtz (Tenebrionidae) at Mecca, Riverside Co., Calif., July 23, 1956 (Wasbauer, 1957, p. 131).

PLANT RECORD.—*Asclepias* sp. (California), *Baccharis* sp. (Texas), *B. glutinosa* (California), *Coyote melon* (California), *Croton californicus* (California), *Eremocarpus setigerus* (California), *Eriogonum fasciculatum* (California), *Gnaphalium beneolens* (California), *Melilotus alba* (California), *Salix* sp. (California), *Tamarix gallica* (California).

39. *Cerceris macrosticta* Viereck and Cockerell

FIGURES 54, 141a,b,c,d,e,f

Cerceris macrosticta Viereck and Cockerell, 1904, p. 133.—Viereck, 1906b, p. 234.—Scullen, 1942, p. 187.—Banks, 1947, p. 9.—Scullen, 1951, p. 1009.
Cerceris ampla Banks, 1912a, p. 16.

FEMALE.—Length 18–20 mm. Black, dark amber, amber, and yellow; punctation coarse and deep; pubescence normal.

Head subequal in width to thorax; upper part of face above antennal scrobes, apical one-third and denticles of mandibles, and apical segments of antennae, all dark amber to black; lower part of face, basal two-thirds of mandibles, and large patch back of eye yellow infused with amber; remaining parts of head variable shades of amber; clypeal margin considerably extended from the central lobe, an extension that is deeply emarginate medially, with clusters of bristles just above the lateral angles, and the sides of this extension showing deep incisions, which are bordered by heavy corinae; clypeal surface process cone shaped with the apex blunt; mandibles with two large, separated denticles; antennae normal in form.

Thorax largely reddish amber with the more elevated areas showing yellow and depressed areas becoming dark amber to black; pronotum, metanotum, patches on the enclosure, most of the propodeum, irregular areas on the pro- and mesopleuron, and the tegulae, all are yellow tinged with light amber; tegulae smooth and not elevated; enclosure with a light medial groove, and the surface largely covered with deep pits; legs largely amber, becoming more or less yellow on the apical parts; wings clouded with amber.

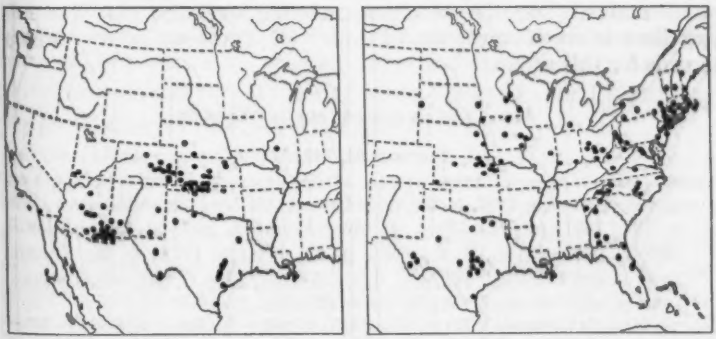
Abdomen largely yellow but in some specimens the more basal terga shows an amber-shaded area in the center; venter yellowish amber; pygidium with the sides slightly convex and both ends truncate.

MALE.—Length 16–18 mm. Black, dark amber, amber, and yellow; punctation coarse and deep; pubescence normal.

Head subequal in width to the thorax; face yellow below antennal scrobes; black to dark amber above the antennal scrobes and most of the vertex; large yellow patches back of the eyes; head otherwise reddish amber; clypeal margin with a broad extension on the medial lobe emarginate, on each side of the extension a low denticle-like process; hair lobes very broad; mandibles dark at the apical end and with a single prominent denticle dark at the apex; antennae with each of the two apical segments about twice the length of the other segments of the flagellum, the terminal one being somewhat curved and blunt.

Thorax largely reddish amber with the more elevated parts yellowish and the depressed parts inclined to be dark; the following parts are yellow infused with amber: divided band on the prothorax, two spots on the scutellum, the metanotum, large patches on the propodeum, patches on the pro- and mesopleuron, and the tegulae; legs largely amber, becoming more yellow apically; wings clouded with amber.

Abdomen largely yellow with light amber on the anterior half of the terga; venter yellow; pygidium almost round with the apical end flattened.



FIGURES 54, 55.—Localities of: 54, *C. macrosticta* Viereck and Cockerell; 55, *C. compar compar* Cresson.

TYPES.—The type male of *C. macrosticta* Viereck and Cockerell, taken in New Mexico, is at the Philadelphia Academy of Natural Sciences, no. 10381. The type male and allotype female of *C. ampla* Banks, taken at Fedor, Lee Co., Texas (Birkmann) are at the Museum of Comparative Zoology, no. 13769.

DISTRIBUTION.—*C. macrosticta* Viereck and Cockerell has been recorded from as far east as central Illinois, north to Nebraska, and west to southern Utah and southern California. It is most abundant in eastern Colorado, Kansas, and south throughout Oklahoma, Texas, New Mexico, and Arizona. Closely related forms are found through Central America and into South America. These may prove to be subspecies.

PREY RECORD.—One record of "beetle, Tenebrionidae," Boulder, Colo., July 26, 1934 (C. H. Hicks); *Metopoloba pruinosa* (Horn) (Tenebrionidae), Baboquivari Mts., Pima Co., Ariz., Aug. 18, 1955 (F. G. Werner-G. D. Butler).

PLANT RECORD.—*Acacia augustissima* (Arizona), *Asclepias* sp. (Arizona), *A. subverticillata* (New Mexico), *Baccharis glutinosa* (Arizona), *B. salicina* (Texas), cotton (New Mexico, Texas), *Eriogonum* sp. (Arizona), *Eupatorium serotinum* (Texas), *Lepidium* sp. (Arizona), *Melilotus* sp. (New Mexico), *M. alba* (Arizona), *Mortonia scabella* (Arizona), *Salix taxifolia* (Arizona), salt cedar (Arizona), *Sapindus* sp. (Arizona), *Verbesina encelioides* (Arizona).

Group V

This group is distinguished by the following characters: (1) The females have a low, cone-like clypeal elevation, which may be reduced to little more than a pronounced convex surface. (2) The hair lobes of the male are very broad, almost meeting medially. (3) The male pygidium is much longer than broad. (4) There are no known prey records for this group.

40a. *Cerceris compar compar* Cresson

FIGURES 55, 142a,b,c

Cerceris compar Cresson, 1865, p. 126.—Packard, 1866, p. 63.—Patton, 1880, p. 404.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 488.—Robertson, 1889, p. 303; 1891, p. 577; 1896c, p. 156.—Ashmead, 1899, p. 295.—Bridwell, 1898, p. 209.—Smith, H. S., 1908, p. 368.—Banks, 1912a, p. 25.—Viereck, 1916, p. 695.—Mickel, 1917b, p. 452.—Britton, 1920, p. 341.—Hendrickson, 1930, p. 160.—Scullen, 1951, p. 1006; 1960, pp. 77–78.

Cerceris jucunda Cresson, 1872, p. 231; 1887, p. 282.—Schletterer, 1887, p. 495.—Ashmead, 1899, p. 295.—Banks, 1912a, p. 26.—Scullen, 1951, p. 1006.

Cerceris jacunda [sic] Hendrickson, 1930, p. 160.

Cerceris jucunda carolina Banks, 1912a, p. 26.—Scullen, 1951, p. 1006.

Cerceris catawba Banks, 1912a, p. 25.—Mickel, 1917b, p. 452.—Scullen, 1951, p. 1006.

FEMALE.—Length 10 mm. Black with yellow markings; punctation and pubescence average.

Head subequal in width to thorax; black except entire face below the antennal scrobes, small spot back of the compound eye, basal

half of the mandibles, and the scape, all of which are yellow; clypeal margin with five closely placed, denticle-like processes, the two lateral ones being much lower and broader than the medial three, which are subequal to each other; the clypeal process reduced to a low rounded elevation slightly more than an exaggerated convex area; mandibles with three closely placed denticles, the most apical one very large; antennae normal in form, fulvous below on the flagellum and darker above.

Thorax black except for two elongate patches on the pronotum, band on the scutellum, an elongate patch on the propodeum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure smooth except for a limited number of deep pits along the lateral borders; mesosternal tubercles absent; legs largely dark fuscous basally to or beyond the middle of the femora, beyond which they are mostly yellow; wings subhyaline but lightly clouded toward the apex.

Abdomen black except for a uniform band on tergum 1 and subequal emarginate bands on terga 2 to 5, all of which are light yellow; venter immaculate; pygidium with the sides convex and the apical end somewhat wider than the basal end.

MALE.—Length 10 mm. Black with yellow markings; punctation and pubescence average.

Head subequal in width to the thorax; black except for the entire face, a minute spot back of the compound eye, small spot on the mandible, and a patch on the scape, all of which are yellow; clypeal border slightly extended, showing three indistinct undulations; hair lobes very wide and almost meeting at the meson; mandibles with one denticle on a broad base; antennae normal in form.

Thorax black except for two elongate patches on the pronotum, a semidivided band on the scutellum, and a patch on the tegulae, all of which are yellow; enclosure smooth except for a slight medial groove and coarse punctations along the lateral margins; mesosternal tubercles very prominent and acute with the points extending toward the posterior; legs colored as follows: forelegs dark to apical end of the femora, beyond which they are largely yellow; the midlegs with the two basal segments dark above and yellow below, the femora dark except for a small yellow spot near the apical end, the tibiae and tarsi yellow except for a dark patch on the tibiae; the hindlegs with the two basal segments largely yellow, the femora dark, and the tibiae and tarsi largely yellow except for a large dark patch on the tibiae; wings subhyaline but clouded near the apex.

Abdomen with subequal light yellow bands on all terga 1 to 6; venter with variable light yellow lines on sternites 2 and 3; pygidium with

sides slightly convex; and the truncate apical end somewhat wider than the basal end.

C. compar Cresson was described from the male. From specimens of females determined as *C. compar* by H. S. Smith at the University of Nebraska, it would appear that Smith was in error in his determination of the females of this species. The writer has accepted the determination of Bridwell, Banks, and others as the correct form. So far as the writer can determine, the two sexes have not been taken associated.

The males of *C. compar compar* Cresson are very close to the males of *C. zelica* Banks. At present they are not separable with any conclusiveness.

TYPES.—The type male of *C. compar* Cresson, from Illinois, is at the Philadelphia Academy of Natural Sciences, no. 1949. The type male of *C. jucunda* Cresson, from Texas, is at the Philadelphia Academy of Natural Sciences, no. 1716. The type male of *C. jucunda carolina* Banks, from Southern Pines, N.C., is at the Museum of Comparative Zoology, Harvard, no. 13785. The type female and allotype male of *C. catawba* Banks, from Southern Pines, N.C., are at the Museum of Comparative Zoology, Harvard, no. 13787.

DISTRIBUTION.—This species is found in limited numbers in most states east of the Rocky Mountains.

PREY RECORD.—None.

PLANT RECORD.—*Apocynum cannabinum* (West Virginia), *Asclepias* sp. (New Mexico), *Berteroa incana* (Massachusetts), *Ceanothus* sp. (North Carolina), Chinquapin (Virginia), *Cicuta maculata* (Iowa), *Colubrina texensis* (Texas), *Hydrangea arborescens* (North Carolina), *Kochia* sp. (North Carolina), *Melilotus alba* (Kansas), *Pastinaca sativa* (New York), *Polytaenia nuttallii* (Texas), Queen Anne's lace (Ohio), rose (Nebraska), *Trifolium* sp. (North Carolina), *Solidago* sp. (Connecticut), *Spiraea* (Connecticut), *Umbelliferae* (Massachusetts).

40b. *Cerceris compar geniculata* Cameron

FIGURE 56

Cerceris geniculata Cameron, 1890, p. 113.—Dalla Torre, 1897, p. 462.—Ashmead, 1899, p. 296.
Cerceris feralis Cameron, 1890, pp. 113–4.—Dalla Torre, 1897, p. 459.—Ashmead, 1899, p. 296.
Cerceris compar geniculata Scullen, 1962, p. 57.

FEMALE.—Length 10 to 11 mm. Structurally like *C. compar compar* Cresson except for the variations in color pattern as indicated below; it averages slightly larger than the latter subspecies.

Head in all respects like that of the nominate subspecies.

Thorax in all respects like the nominate subspecies except the

hindfermora, which are black with a large yellow area over the apical third.

Abdomen as in the nominate subspecies except there is a patch laterally on the posterior border of the second tergum.

MALE.—Length 10 to 11 mm. Black with yellow markings; punctation average; pubescence short.

Head subequal in width to the thorax; black except for the entire face, basal two-thirds of the mandibles, and the scape, all of which are yellow; clypeal surface slightly convex; margin of the medial clypeal lobe with three dark denticles; hair lobes broad, extending from the eyes to mesad of the lateral denticles; mandibles with two medial denticles, one above and one below, each on a broad base; antennae normal in form.

Thorax black except for a broad divided band on the pronotum, evanescent small spots on the propodeum, and the tegulae, all of which are yellow; tegulae smooth and slightly expanded laterally; mesosternal tubercle prominent and semitruncate; fore- and hindlegs largely yellow with black areas dorsally on the coxae, trochanter, and basal end of the femora; the hindlegs with the femora largely black but with a yellow patch apically; the remaining parts of the hindlegs similar in color to the corresponding parts on the first two pairs of legs; wings subhyaline but clouded along the anterior border.

Abdomen with broad posterior bands on terga 1 and 3, tergum 2 immaculate except for a trace of yellow laterally; terga 4, 5, and 6 with narrow emarginate bands; terga 7 immaculate; sternum black except for an irregular narrow band on sternite 3 and evanescent lateral spots on sterna 4 and 5; pygidium with sides slightly convex, the apical end truncate and slightly broader than the basal end.

This subspecies is distinguished from the other subspecies by the blacker legs of both sexes and the more prominent mesosternal process on the male.

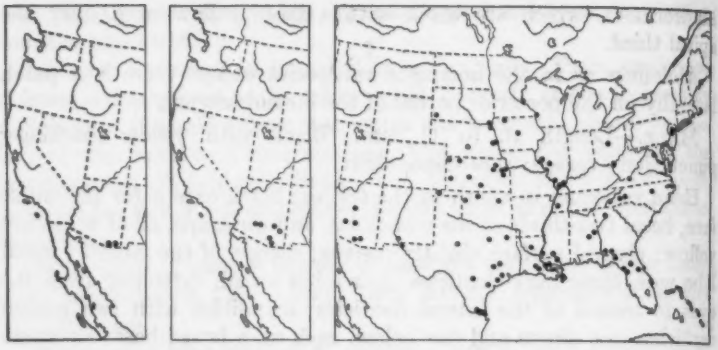
TYPES.—The type female of *C. geniculata* Cameron and type male of *C. feralis* Cameron, both from Mexico, are at the British Museum, nos. 21.1,366 and 21.1,372, respectively.

DISTRIBUTION.—This subspecies is primarily a Mexican form but the following records are from near the Mexican border. Specimens are as follows:

ARIZONA: ♀, 3♂♂, Canelo, Santa Cruz Co., July 30, 1956 (G. D. Butler); ♂, 8 mi. N. Douglas, 4300 ft., Aug. 7, 1946 (H. A. Scullen); ♂, Douglas, 4000 ft., July 30, 1959 (H. E. Evans).

PREY RECORD.—None.

PLANT RECORD.—None.



FIGURES 56–58.—Localities of: 56, *C. compar geniculata* Cameron; 57, *C. compar orestes* Banks; 58, *C. insolita insolita* Cresson.

40c. *Cerceris compar orestes* Banks

FIGURE 57

Cerceris orestes Banks, 1947, pp. 13–14.
Cerceris compar orestes Scullen, 1962, p. 57.

FEMALE.—10 mm. Black with light yellow or cream-colored markings; punctation and pubescence average.

Head subequal to or slightly narrower in width than the thorax; entire face, spot back of compound eyes, two small spots on vertex back of the ocelli and a little to one side, the basal half of the mandibles, and a patch on the scape, all are cream colored; clypeal border with three denticles, the medial one more acute than the others; clypeal process reduced to a low rounded elevation slightly more than an exaggerated convex area; mandibles with two denticles, the more apical one broad and blunt, and a low rounded ridge basad of the denticles; antennae normal in form.

Thorax black except for a divided band on the pronotum, band on the scutellum, a large hook-shaped patch on the propodeum, and the tegulae, all of which are light yellow; tegulae low and smooth; mesosternal tubercle absent; legs largely black to or slightly beyond the middle of the femora, beyond which they are largely creamy yellow with elongate dark stripes on the tibiae and the hindtarsi; wings subyhaline with a clouded area along the anterior margins.

Abdomen with broad bands on terga 1 and 3, tergum 2 black except for yellow lateral patches, broad but deeply emarginate bands on terga 4 and 5; venter with variable amounts of yellow on all sternites but more pronounced on 1, 3, and 4; pygidium with sides convex and ends subequal and rounded.

MALE.—Not recognized.

The female of *C. compar orestes* Banks closely resembles *C. compar compar* Cresson, but the former can be separated by the absence of a band of yellow on its tergum 2 and the presence of a hook-shaped patch on its propodeum. It also resembles *C. insolita*, but the former can be separated by the shape and size of its clypeal process and its hook-shaped yellow patch on the propodeum.

TYPE.—The type female of *C. orestes* Banks, from Patagonia, Ariz., August 1–4 (Bequaert), is at the Museum of Comparative Zoology, Harvard, no. 27637.

DISTRIBUTION.—This subspecies has been taken largely in Arizona and northern Mexico. Specimens are as follows:

ARIZONA: 2 ♀ ♀, 3 ♂ ♂, Canelo, July 30, 1956 (G. D. Butler); ♂, Cortaro, July 28, 1956, cotton (T. Dees); ♂, 3 mi. NE. Cottonwood, July 7, 1952 (L. D. Beamer and party); 2 ♂ ♂, Fort Thomas, Graham Co., 2700 ft., Aug. 7, 1946 (H. A. Scullen); ♂, Hassayampa, Maricopa Co., Aug. 26 (J. C. Bradley); ♂, Patagonia, Santa Cruz Co., Aug. 20 (J. Bequaert); 12 ♂ ♂, Patagonia, Aug. 24, 25, 1955, *Cleome jonesii* (G. D. Butler, F. G. Werner); ♀, Patagonia, Aug. 24, 1954; 4 ♀ ♀, Patagonia, Aug. 24, 1938, Aug. 25, 1955, Aug. 10, 1958 (F. G. Werner); ♂, Phoenix, June 1, 1927 (A. A. Nichol); 7 ♂ ♂, Tempe, July 30 to Aug. 2 (J. Bequaert); 11 ♂ ♂, Tempe, Aug. 4, 5, 1917; 3 ♂ ♂, Tucson, July 13, 1954, July 14, 17, 1955, alfalfa, *Wislizenia* sp. (G. D. Butler); 5 ♂ ♂, 10 mi. E. Tucson, July 30, 1955, *Croton* sp., *Lepidium* sp. (G. D. Butler); ♂, Sahuarita, July 5, 1956, cotton (Butler and Williams); ♂, San Carlos, July 15, 1955, alfalfa (N. J. Nerney); ♂, St. David, July 27, 1955, alfalfa (Butler and Werner).

PREY RECORD.—None.

PLANT RECORD.—Alfalfa, *Cleome jonesii*, cotton, *Croton* sp., *Lepidium* sp., *Wislizenia* sp. (all in Arizona).

41a. *Cerceris insolita insolita* Cresson

FIGURE 58

Cerceris insolita Cresson, 1865, p. 129.—Packard, 1866, p. 63.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 494.—Ashmead, 1899, p. 295.—Smith, H. S., 1908, p. 270.—Banks, 1912a, p. 23.—Mickel, 1917b, p. 451.—Banks, 1947, p. 15.—Scullen, 1951, p. 1008; 1962, p. 57.

Cerceris intractibilis Mickel, 1916, p. 411; 1917b, p. 451.—Scullen, 1951, p. 1008.

FEMALE.—Length 10 mm. Black with yellow markings; punctation and pubescence average.

Head subequal in width to thorax, black except for the frontal eye patches, the apex of the clypeal process, a spot above the process, base of mandibles, a minute evanescent spot back of the ocelli, and the scape, all of which are yellow; extension of the clypeal border shows five subequal small denticles; clypeal elevation somewhat cone shaped with a blunt point and a smooth, slightly concave lower surface; mandibles with three denticles, the most apical one much the largest and the most basal one the smallest; antennae normal in form.

Thorax black except for two elongate patches on the pronotum, band on the scutellum, small patches on the propodeum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure with a light medial groove and deep pits laterally; mesosternal tubercle absent; legs largely amber to nearly black toward the base, becoming lighter on the more apical segments; wings subhyaline but clouded along the anterior margin.

Abdomen black except for a wide band on tergum 1, a wide emarginate band on tergum 3, narrow lines on terga 4 and 5, all of which are yellow; venter immaculate; pygidium with sides convex and both ends rounded and subequal.

There is a tendency for the band on tergum 3 to become less emarginate and the legs to become darker in specimens from the South Central States; small spots of yellow may appear laterally on some sternites.

MALE.—Length 10 mm. Black with yellow markings; punctation somewhat coarser than average; pubescence average.

Head subequal in width to thorax; black except entire face below antennal scrobes and patch on the scape, which are yellow; clypeal border with three indistinct denticles; hair lobes broad, almost meeting; mandibles without denticles but with a carina medially.

Thorax black except for two elongate patches on the pronotum, the scutellum, small patch on the propodeum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure with a light medial groove and deeply pitted laterally; mesosternal tubercle absent; fore- and midlegs dark to near the apical end of the femora, beyond which they are light amber; basal two segments of the hindlegs largely yellow, femora dark amber, remaining segments lighter amber infused with yellow; wings subhyaline, clouded along the anterior margins.

Abdomen black except medium wide bands on terga 1 and 3, broken lines on terga 4, 5, and 6, all of which are yellow; venter with a yellow band on sternite 3; pygidium with sides subparallel and ends subequal in width.

The male of *C. insolita* Cresson is close to male of *C. zelica* Banks, from which the former can be separated by the immaculate second tergum of its abdomen. The female is close to *C. compar orestes* Banks, from which the former can be separated by the form of its clypeal elevation. Males from the southwest are difficult or impossible to separate at present from males of *C. compar orestes* Banks. Females of *C. compar orestes* Banks are distinct and have been taken only in the southwestern desert area. *C. insolita insolita* Cresson can be confused with *C. tolteca* Saussure, which it superficially resembles.

The males of these species may be separated by the form of the pygidium and the females by the clypeal processes.

TYPES.—The type male of *C. insolita* Cresson, from Illinois, is at the Philadelphia Academy of Natural Sciences, no. 1954. The type female of *C. intractibilis* Mickel, from Child's Point, Nebr., July 14, 1915 (E. M. Partridge), is at the University of Nebraska.

DISTRIBUTION.—Throughout the Central and Eastern States.

PREY RECORD.—None.

PLANT RECORD.—*Achillea* sp. (Texas), *Ambrosia psilostachya* (Mississippi), *Ampelopsis arborea* (Texas), cotton (Texas), *Eupatorium* (Texas), *Hydrangea arborescens* (North Carolina), *Melilotus alba* (Florida), peach (Mississippi), *Rhus glabra* (Florida), *Solidago* (Kansas), sumac (Texas), *Tamarix gallica* (Kansas).

41b. *Cerceris insolita albida*, new subspecies

FIGURE 59

FEMALE.—Length 10 mm. Black with creamy-white markings; structurally like the nominate subspecies *C. insolita insolita* Cresson except for the color and extent of the markings.

Head black except for the face below the antennal scrobes, with an irregular dark line about the base of the clypeal elevation, small spot back of the eye, basal half of the mandibles, and a patch on the scape, all of which are creamy white.

Thorax black except for two elongate patches on the pronotum, band on the scutellum, evanescent patches on the metanotum, patches on the propodeum, and a small patch on the tegulae, all of which are creamy white; legs black to fuscous on the two basal segments, the femora fulvous to black with creamy-white markings, and the more apical segments creamy white, fulvous, and fuscous in variable amounts.

Abdomen with a medium width band on terga 1 and 3, narrow bands on terga 4 and 5, evanescent small patches on the lateral posterior angles of tergum 2; bands on terga 3, 4, and 5 deeply emarginate; venter immaculate; pygidium fulvous.

MALE.—The color and color patterns of the male follow those of the female with the exception that the entire face is creamy white and bands of creamy white appear on sternites 3, 4, 5, and 6; the band on tergum 3 is inclined to be less emarginate on the male than on the female. Structural characters other than the colors are the same as for the nominate subspecies.

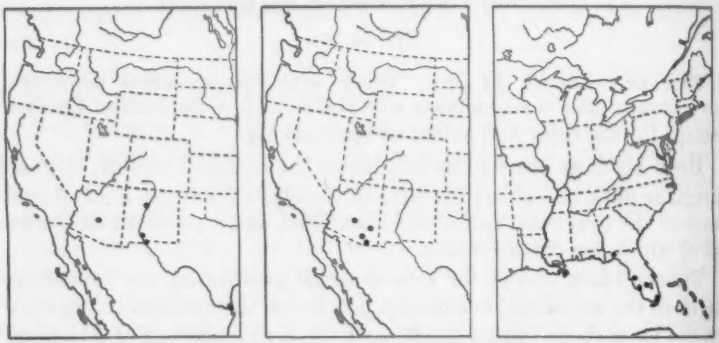
TYPES.—The type female and allotype male, from Las Cruces, N. Mex., 3880 ft. elevation, June 18, 1942 (H. A. Scullen), are at the U.S. National Museum, no. 66168. Paratypes are as follows:

ARIZONA: ♂, Tempe, Aug. 4, 1917. NEW MEXICO: 10♂♂, Albuquerque, 5000 ft., June 27, 1931 (H. A. Scullen); 2♂♂, Albuquerque (Don Prentiss); 3♂♂, Las Cruces, Aug. 7, 28 (Cockerell); ♀, ♂, Albuquerque, June 18–19, 1942 (E. C. Van Dyke); 5♂♂, Albuquerque, June 18, 1942 (H. A. Scullen); ♀, Albuquerque, 3950 ft., Aug. 2, 1946 (H. A. Scullen); ♂, Albuquerque, June 12, 1950 (L. D. Beamer); 2♂♂, Albuquerque, July 15, 1952 (C. Laing, W. LaBerge, R. H. and L. D. Beamer); ♂, Mesilla, Aug. 23 (Cockerell). TEXAS: 3♂♂, El Paso, July 17, 1917 (Bequaert); 2♂♂, El Paso, 3700 ft., June 20, 1942 (H. A. Scullen); ♂, Santa Elena Canyon, Big Bend National Park, 2145 ft., Aug. 25, 1954 (R. M. Bohart).

DISTRIBUTION.—Southern Arizona, southern New Mexico, and southwestern Texas.

PREY RECORD.—None.

PLANT RECORD.—None.



FIGURES 59–61.—Localities of: 59, *C. insolita albida* Scullen; 60, *C. insolita atrafemori* Scullen; 61, *C. rufa* Scullen.

41c. *Cerceris insolita atrafemori*, new subspecies

FIGURES 60, 143a,b,c

FEMALE.—Length 11 mm. Structurally like the nominate subspecies *C. insolita insolita* Cresson except for variations in the color markings as given below.

Head markings are creamy white and not yellow as in the nominate subspecies.

Thorax shows a small secondary evanescent yellow spot on the propodeum near the apex of the enclosure; the metanotum shows more or less yellow; legs are black with creamy-white markings; hindfemora are black with a creamy-white patch near the apical end.

Abdomen with the band on tergum 3 broad with little or no emargination; other abdominal bands nearly equal to half the tergum and

with slight emargination; venter with little or no markings; pygidium ferruginous.

MALE.—Unknown.

TYPES.—The type female, from Phoenix, Ariz., 1100 ft., Aug. 10, 1946 (H. A. Scullen), is at the U.S. National Museum, no. 66169. Paratypes are as follows:

ARIZONA: ♂, Canelo, July 30, 1956 (G. D. Butler); ♀, Cortaro, July 28, 1956, cotton (T. Dees); ♀, Ft. Thomas, Graham Co., 2700 ft., Aug. 7, 1946 (H. A. Scullen); ♀, Tucson, 2500 ft., Aug. 13, 1946 (H. A. Scullen); ♀, 10 mi. E. Tucson, July 30, 1955, *Croton* (G. D. Butler); ♀, S. Tucson, July 26, 1956, cotton (C. Williams).

DISTRIBUTION.—Known only from Arizona.

PREY RECORD.—None.

PLANT RECORD.—Cotton (Arizona), *Croton* sp. (Arizona).

42. *Cerceris rufa*, new species

FIGURE 61

FEMALE.—Length 10 mm. Black with yellow and rufous markings; punctation and pubescence average.

Head subequal in width to the thorax; black except the entire face below the antennal scrobes, small spot back of the eye, and the basal two-thirds of the mandibles, all of which are yellow, heavily infused with fulvous; clypeal border with three blunt denticles, to the side of each lateral denticle a slight carina; the clypeal process is reduced to a low rounded elevation slightly more than an exaggerated convex area; mandibles with three denticles, the most apical one very large with a deep incision at its apical side and the most basal one low and broad; antennae normal in form.

Thorax black except for a semidivided band on the pronotum, the scutellum, most of the propodeum exclusive of the enclosure, and the tegulae, all of which are ferruginous; tegulae low and smooth; enclosure with a medial groove and deep pits along the lateral margins; mesosternal tubercle absent; legs ferruginous; wings subhyaline clouded with ferruginous.

Abdomen with the first three terga rufous and the posterior three black; venter with the first two sternites rufous, the third sternite black and rufous, and the remaining sternites black; pygidium with the sides slightly convex and ends subequal in width.

MALE.—Length 10 mm. General coloring as on the female; punctation and pubescence as on the female.

Head black except the entire face below the antennal scrobes and the basal half of the mandibles, which are yellow infused with fulvous; clypeal border with three low denticles; hair lobes broad, extending

from the eye to the lateral border denticles; mandibles with a single denticle having a broad base; antennae normal in form.

Thorax black except for a divided band on the pronotum, the scutellum, a large area on the propodeum, and the tegulae, all of which are ferruginous; tegulae low and smooth; enclosure with a light medial groove and deep punctation over most of the side areas; mesosternal tubercle very prominent and acute, with the points extending toward the posterior; legs fulvous with some parts becoming more yellow; wings subhyaline clouded with ferruginous.

Abdomen with the first three tergites rufous and a trace of fulvous to yellow lines along the anterior margins of terga 2 and 3, the remaining four terga black; venter black except for sternites 1, 2, and patches on 3, which are rufous; pygidium with sides slightly convex and the ends subequal in width.

Both sexes of *C. rufa* are very close in structure to *C. compar* Cresson and possibly should be considered a subspecies of the latter. On the basis of its very different color and color pattern, it is considered here a distinct species.

TYPES.—The type female and the allotype male, taken at South Miami, Fla., by S. Graenicher, on May 26, 1927, and March 14, 1927, respectively, are in the U.S. National Museum, no. 66170. Paratypes are as follows:

FLORIDA: ♀, Cleveland, Apr. 3 1938 (D. M. DeLong); 5♂♂, S. Miami, Mar. 14, 1927 (S. Graenicher); 4♂♂, Homestead, June 22, 1951 (Beamer-Wood); ♂, Lutz, Mar. 31, 1927 (Krautwurm), Carnege Museum, no. 8096; ♂, Monticello, May 25 (G. Fairchild); ♂, Brighton, April 7, 1937 (J. G. Franclemont).

DISTRIBUTION.—Florida.

PREY RECORD.—None.

PLANT RECORD.—None.

43. *Cerceris selica* Banks

FIGURES 62, 144a,b,c,d

Cerceris selica Banks, 1912a, p. 23.—Scullen, 1951, p. 1011.

FEMALE.—Length 12 mm. Black with yellow markings; legs fulvous; punctation and pubescence normal.

Head subequal in width to thorax; black except large frontal eye patches, lateral lobes of the clypeus, clypeal elevation, patch above the elevation, small spot back of the eye, and the basal half of the mandibles, all of which are yellow; clypeal border with three blunt denticles; clypeal elevation cone shaped with a smooth flattened area on the lower surface; mandibles with three denticles fused at the base, the apical one much the largest; antennae normal in form, fuliginous below and darker above.

Thorax black except for a divided band on the pronotum, a semidivided band on the scutellum, a small patch on the propodeum, and a spot on the tegulae, all of which are yellow; tegulae low, smooth, and fulvous, with a yellow spot; enclosure with a slight medial groove and deep pits along the lateral margins; mesosternal tubercle absent; legs fulvous except for limited darker areas on the forefemora and all basal segments; wings subhyaline, tinged with amber and darker along the anterior margin.

Abdomen with bands on all terga, but those on terga 1 and 2 broader, that on 2 deeply emarginate, those on 3, 4, and 5 narrow; venter immaculate; pygidium long and narrow with the basal end the smaller.

MALE.—Length 12 mm. Black with yellow markings; legs fulvous and yellow; punctation and pubescence average.

Head black except the entire face, small spot back of the eye, small spot on the base of the mandible, and patch on the scape, all of which are yellow; clypeal border with three low denticles; hair lobes very broad and almost meeting medially; mandibles with a single denticle, which has a very broad base; antennae normal in form.

Thorax black except for a divided band on the pronotum, semidivided band on the scutellum, and a small patch on the tegulae, all of which are yellow; tegulae low and smooth; enclosure pitted along the lateral margins; mesosternal tubercle in the form of a carina extending to a point apically; forelegs dark to beyond the middle of the femora, beyond which they are yellow infused with amber; mid- and hindlegs with the femora fulvous and the remaining parts largely yellow; wings subhyaline, tinged with amber and darker along the anterior margins.

Abdomen with subequal bands on all terga; venter with elongate yellow patches on sternites 2 and 3; pygidium long with the basal end the smaller.

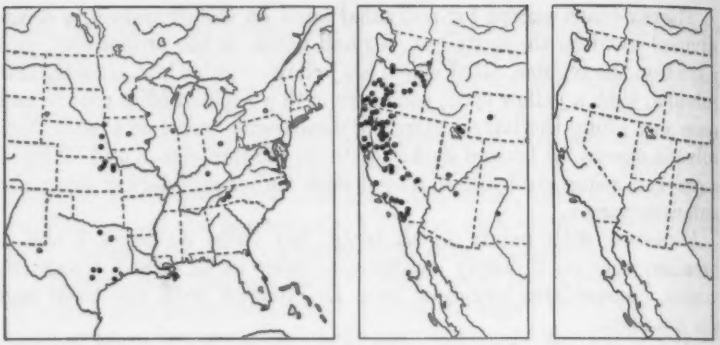
C. zelica Banks is similar to *C. compar* Cresson in size and coloring but the form of the clypeal elevation will separate the females. No satisfactory characters have been found to separate the males of the two species. No doubt the males of the two species have been confused. The description of the male is based on the type and specimens determined by Banks from the type locality.

TYPES.—The type male and the allotype female of *C. zelica* Banks, from Fedor, Lee Co., Tex., June 7 (Beckmann), are at the Museum of Comparative Zoology, Harvard, no. 13773.

DISTRIBUTION.—Throughout the Eastern and Central States.

PREY RECORD.—None.

PLANT RECORD.—None.



FIGURES 62–64.—Localities of: 62, *C. zelica* Banks; 63, *C. aequalis aequalis* Provancher; 64, *C. aequalis bolingeri* Scullen.

Ungrouped Species

The following species have not been separated into distinct groups as yet. There is a distinct affiliation between certain species, however, and further study may warrant the recognition of new, isolated groups.

44a. *Cerceris aequalis aequalis* Provancher

FIGURES 63, 145a,b,c

Cerceris aequalis Provancher, 1888, ♀, p. 417; 1889, new species ♀, pp. 417–8, 450.—Dalla Torre, 1897, p. 449.—Ashmead, 1899, p. 296.—Gahan and Rohwer, 1917, p. 335.—Banks, 1947, pp. 16–17.—Scullen, 1951, p. 1004.
Cerceris vicinoides Viereck and Cockerell, 1904, p. 140.—Scullen, 1951, p. 1004.
Cerceris psamathe Banks, 1912a, p. 21.—Scullen, 1951, p. 1004.

FEMALE.—Length 11 mm. Black with yellow markings; punctation fine and more scattered than average; pubescence average.

Head subequal in width to the thorax, black except for large frontal eye patches, dorsal surface of the clypeal process, lateral lobes of the clypeus, base of the mandibles, spot back of the eye, and patch on the scape, all of which are yellow; clypeal border with an extension from the medial lobe that has a sinuate margin and a smooth depressed area above the margin; clypeal process with sides converging to a rounded end that points ventrad at about a 45° angle, concave and black below, yellow above with a black apical margin, mandibles with two subequal denticles fused at the base, basad of which appears a small evanescent denticle in some specimens; antennae normal in form.

Thorax black except for two widely separated patches on the pronotum, the metanotum, large patch on the propodeum, and the

tegulae, all of which are yellow; tegulae low and smooth; enclosure finely rugose with the ridges running at an angle to the base; mesosternal tubercles absent; legs largely yellow with the two basal segments, base of femora, and apical end of the midfemora black; wings subhyaline, slightly clouded apically.

Abdomen with a broad divided band on tergum 1, broad deeply emarginate bands on terga 2 to 5; broad bands on sternites 2 to 4, and a divided broad band on sternite 5; pygidium wedge shaped, with the basal end broad and the apical end very small and rounded.

MALE.—Unrecognizable. In the *aequalis-varians* complex.

The female of *C. aequalis* Provancher closely resembles the female of *C. varians* Mickel in size, structure, and color pattern, from which it is separated easily by the form of the clypeal process. So far the present author has been unable to distinguish the males.

TYPES.—The lectotype female of *C. aequalis* Provancher, from California, is at the U.S. National Museum, no. 1974. The type female (not a male as indicated in the original description), of *C. vicinoides* Viereck and Cockerell, from Pecos, N. Mex., June 25, 1903, on *Fallugia* (W. P. Cockerell), is at the Philadelphia Academy of Natural Sciences, no. 10387. The type female of *C. psamathe* Banks, Lee Co., Tex. (Birkmann), is at the Museum of Comparative Zoology, Harvard, no. 13780.

DISTRIBUTION.—The nominate subspecies is taken mostly in California and Oregon, with limited records from adjoining states.

PREY RECORD.—None.

PLANT RECORD.—*Achillea* sp. (Oregon), *Anaphalis margaritacea* (California), *Ceanothus fendleri* (Arizona), *Eriogonum* (California, Oregon), *Lotus glaber* (California), *Ranunculus* sp. (California).

44b. *Cerceris aequalis bolingeri*, new subspecies

FIGURES 64, 146a,b,c

FEMALE.—Length 11–12 mm. Black with white to creamy-white markings; punctation fine and not crowded; pubescence average; like nominate subspecies *C. aequalis aequalis* Provancher in all respects except as indicated.

Head markings white; clypeal process almost verticle to the plane of the face, much longer than on the nominate subspecies, with sides subparallel and the apical end rounded.

Thorax color pattern and structures as in the nominate subspecies except colors are white to creamy white; legs are immaculate to the apical ends of all femora, remaining segments white and black in variable amounts.

Abdomen as in the nominate subspecies except the markings are white and the venter is immaculate.

TYPES.—The type female, from Jacob's Cabin, Hart Mt., Lake Co., Oreg., 6600 ft., July 16, 1937 (Bolinger and Jewett), in the U.S. National Museum, no. 66171. Paratypes are as follows:

OREGON: ♀, Jacob's Cabin, Hart Mt., Lake Co., 6600 ft., July 16, 1937 (Bolinger and Jewett); ♀, Hart Mt., July 16, 1937. NEVADA: ♀, Emigrant Pass, Eureka Co., June 19, 1952 (E. I. Schlinger).

DISTRIBUTION.—This subspecies has been taken only on Hart Mt., Lake Co., Oreg., and one specimen in Nevada as indicated above.

PREY RECORD.—None.

PLANT RECORD.—None.

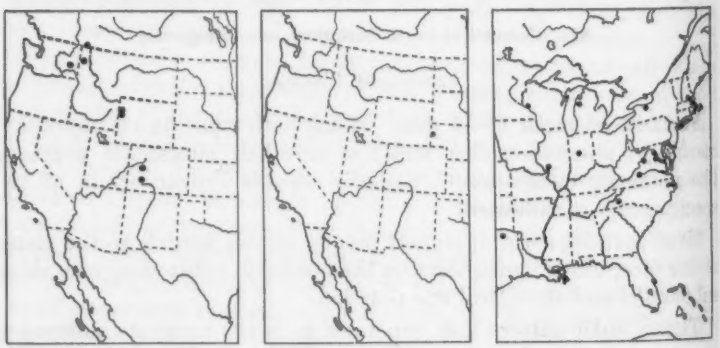
44c. *Cerceris aequalis idahoensis*, new subspecies

FIGURES 65, 147a,b,c

FEMALE.—Length 11 mm. Black with creamy-yellow markings; structurally like the nominate subspecies *aequalis aequalis* Provancher except for the more acute clypeal process and the much lighter and more limited yellow markings.

Head with medium-sized frontal eye patches, patch on the clypeal process, spot back of the eye, base of mandibles and spot on the scape, all of which are creamy yellow; clypeal border as in the nominate subspecies; mandibles with the basal denticle somewhat more distinct than in the nominate subspecies but much smaller than the other denticles.

Thorax black except for two small variable spots on the pronotum, small evanescent spots on the metanotum, and small patches on the tegulae, all of which are creamy yellow; legs black to the apical ends



FIGURES 65–67.—Localities of: 65, *C. aequalis idahoensis* Scullen; 66, *C. alceste* Mickel; 67, *C. astarte* Banks.

of femora, beyond which there are variable amounts of light yellow and amber.

Abdomen with two small patches on tergum 1, a broken emarginate line on tergum 2, emarginate narrow bands on terga 3 and 4, and small evanescent lateral patches on tergum 5; venter immaculate.

MALE.—Unknown.

TYPES.—The type female of *C. aequalis idahoensis* Scullen, from Craig's Mt., Idaho (Wm. J. Fox), is at the Philadelphia Academy of Natural Sciences, no. 5040. Paratypes are as follows:

BRITISH COLUMBIA: ♀, Chilcotin, June 15, 1929 (G. J. Spencer); ♀, Creston, 2816 ft., 1924 (C. S. Lallamand). COLORADO: ♀, 5 mi. N. Cedaredge, July 11, 1938 (U. Lanham); ♀, Lake City, June 29, 1937 (R. H. Beamer). IDAHO: ♀, Craig's Mt. (Wm. J. Fox); ♀, Chilco, Kootenai Co., July 2, 1952 *Achillea* sp., (W. F. Barr). OREGON: ♀, Lick Creek Ranger Station, Wallowa National Forest, 4600 ft., Aug. 16, 1937 (Bolinger and Jewett); ♀, Ochoco Pass, Ochoco National Forest, 5000 ft., July 10, 1955 (J. F. G. Clarke). WASHINGTON: ♀, Ritzville, June 16, 1920 (R. C. Shannon). WYOMING: 2♀♀, Jackson, 6300 ft., July 13, 1920; 2♀♀, Jenny Lake, Grand Teton National Park, June 1941 (G. E. Bohart).

DISTRIBUTION.—Largely in the northern Rocky Mountains area, Idaho, and bordering states.

PREY RECORD.—None.

PLANT RECORD.—*Achillea* sp. (Oregon).

45. *Cerceris alceste* Mickel

FIGURES 66, 148a,b,c

Cerceris alceste Mickel, 1917a, p. 333; 1917b, p. 449.—Scullen, 1951, p. 1005.

FEMALE.—Length 18 mm. Black with yellowish-white markings and variable shades of reddish brown.

Head black except face and sports back of the compound eyes, which are yellowish white, the vertex and genae, which are ferruginous; clypeal border with a medial extension on the sides, on which are two slightly rounded denticles opposite the points of the clypeal process; clypeal process somewhat lunar in shape with a lateral secondary projection on each side; mandibles with three low denticles, the medial one being much more acute than the other two, which are low and broad; antennae ferruginous at the base, becoming fulvous apically.

Thorax largely black except divided band on pronotum, scutellum, metanotum, large patches on the propodium, spot on the pleuron, and the tegulae, all of which are yellowish white; most of the light markings show a ferruginous border; enclosure with fine longitudinal lines tending to radiate to the side; legs ferruginous; wings subhyaline, becoming darker at the apex.

Abdomen largely ferruginous with yellowish-white markings; semidivided patches of yellowish white on tergum 1; terga 2 to 5 with broad yellowish white bands deeply emarginate with ferruginous anteriorly and the basal margins of all terga black; venter light amber with yellow spots on sternites 2 to 5; pygidium narrowing apically to a rounded end.

MALE.—Unknown. Mickel (1918, p. 336) indicated *C. fugatrix* Mickel might be the male of *C. alceste* Mickel.

The secondary process on the sides of the clypeal process of the unique holotype of *C. alceste* Mickel and its greater amount of ferruginous markings are the only characters that separate it from specimens of *C. stigmosalis* Banks (*C. fugatrix* Mickel). This similarity to the latter species and the fact that *C. alceste* Mickel is represented only by the unique holotype, which was taken at Michell, Nebr., on the same date as the male type of *C. fugatrix* Mickel, indicates the holotype female of *C. alceste* Mickel is only an extreme abnormality of *C. stigmosalis* Banks. This view is supported further by the fact that some female specimens of *C. stigmosalis* Banks show slight indications of elevations on the sides of the clypeal process.

TYPE.—The holotype female of *C. alceste* Mickel, from Mitchell, Nebr., Aug. 4, 1916 (C. E. Mickel), is at the University of Nebraska.

DISTRIBUTION.—The species is known only from the type locality of Mitchell, Nebr.

PREY RECORD.—None.

PLANT RECORD.—None.

46. *Cerceris astarte* Banks

FIGURES 67, 149a,b,c

Cerceris astarte Banks, 1913b, p. 424, pl. 1, fig. 12.—Scullen, 1951, p. 1005.

FEMALE.—Length 10 mm. Black with yellow markings; punctation and pubescence average.

Head subequal in width to the thorax; black except for large frontal eye patches, spot on the clypeal process, and evanescent small spot back of compound eye, and small spot on the scape, all of which are yellow; border of the clypeus with four prominent denticles, the mesal pair somewhat the larger, the clypeal process short, with the sides converging to a rounded apex; mandibles with two denticles that are broad and low, the more basal one bifid; antennae normal in form, dark except for a small yellow spot on the scape.

Thorax black except for two widely separated spots on the pronotum, the metanotum, large patches on the propodeum, and patches on the tegulae, all of which are yellow; tegulae low and smooth; enclosure faintly ridged longitudinally in the center but with ridges more pronounced laterally and with a medial groove; mesosternal

tubercles absent; legs dark to or near the apical ends of the femora, beyond which they are yellow infused with brown; wings subhyaline clouded with amber and darker toward the apex.

Abdomen with subequal bands covering about the posterior third of terga 2 to 5; tergum 1 with the band broken into two patches; venter immaculate; pygidium with the sides subparallel and the apical end rounded.

MALE.—Length 9 mm. Black to dark fuscous with light yellow (almost cream) markings; punctation somewhat less crowded than average; pubescence slightly longer than average.

Head slightly wider than the thorax; black except for the face, base of mandibles, and the scape, all of which are yellow; clypeal border with two distinct, widely separated denticles, which are black; hair lobes subequal in width to the width of the lateral lobes; surface of the medial lobe of the clypeus depressed but not concave; manibles with a low sinuate carina but no distinct denticles; antennae with the apical segment blunt and slightly curved.

Thorax black except two patches on the pronotum, the metanotum, two patches on the propodeum, and the tegulae, all of which are light yellow; tegulae low and smooth; enclosure smooth except for a central groove and limited ridges in the lateral angles; mesosternal tubercles absent; first pair of legs dark over the basal parts to the apical ends of the femora, otherwise yellow shaded with fulvous; the second pair of legs yellow shaded with fulvous except for a dark area on the basal half of the femora; the third pair of legs are dark except the basal parts to middle of the femora and the basal half of the tibiae, which are yellow clouded with fulvous; wings subhyaline except for the usual clouded area at the apex.

Abdomen dark except for two lateral patches on the first tergum, subequal narrow bands on terga 2 to 6, and small lateral patches on sternites 2 to 4, all of which are light yellow; pygidium with sides subparallel but slightly convex, the apical end truncate and the lateral angles slightly rounded.

The identification of the males is based on specimens collected by Dr. K. V. Krombein at Powder Mills, N.C.

The female of *C. astarte* Banks closely resembles the female of *C. nigrescens arelate* Banks in size and color pattern as well as in its distribution, but the form of the clypeal process and the pygidium will easily separate them.

TYPES.—The type female of *C. astarte* Banks, from Falls Church, Va., Sept. 7, 8, 1912, is at the Museum of Comparative Zoology, Harvard, no. 13788.

DISTRIBUTION.—This rare species has been taken in the Northeast-

ern States, from Wisconsin and Illinois east to New England and south to North Carolina. Specimens are as follows:

ILLINOIS: 4 ♀ ♀, Carlinville, 1901, (Robertson); ♀, Muncie, Sept. 21, 1930. IOWA: ♀, Lodges State Park, Boone, Aug. 22, 1934 (Scullen). MASSACHUSETTS: ♀, Millon, Aug. 14, 1898 (P. G. Bolster); ♀, Natick, Sept. 1, 1934 (C. A. Frost); ♀, Wollaston, June 1, 1895 (F. H. Sprague). MICHIGAN: ♀, Lake Co., 1947 (R. R. Dreisbach). NEW HAMPSHIRE: ♀, Pelham, Aug. 29, 1905 (Bridwell); 6 ♀ ♀, Pelham, Sept. 5, 1905. NEW YORK: ♀, Montauk, Long Island, Sept. 4, 1953 (Roy Latham); ♀, Northwest, Long Island, June 3, 1947 (Roy Latham); 2 ♀ ♀, Powder Mills, Aug. 24, 1955 (K. V. Krombein). NORTH CAROLINA: ♂, Black Mts., Mount Mitchell, 5000–6711 ft., Sept. 6, 1930 (N. Banks); ♀, Valley of Black Mts., Sept. 11, 1906 (W. Beutenmuller). VIRGINIA: ♀, Brushy Mts., Rockbridge, Sept. 17, 1934 (L. K. Gloyd); ♀, 2 ♂ ♂, Dunn Loring, Aug. 28, 1948, Aug. 21, 1949 (K. V. Krombein); 2 ♀ ♀, Falls Church, Sept. 1 (N. Banks). WEST VIRGINIA: ♀, Cheat Mt., Aug. 23. WISCONSIN: ♀, Maiden Rock, Aug. 4–10, 1910.

PREY RECORD.—None.

PLANT RECORD.—None.

47. *Cerceris atramontensis* Banks

FIGURES 68, 150a,b,c

Cerceris atramontensis Banks, 1913b, p. 425, pl. 1, fig. 8.—Scullen, 1951, p. 1005.—Krombein, 1956, p. 43; 1958a, p. 197.

Cerceris arbuscula Mickel, 1916, p. 410; 1917b, p. 450.—Scullen, 1951, p. 1005.

FEMALE.—Length 13 mm. Black with yellow markings; punctation and pubescence average.

Head slightly wider than the thorax; black except for medium-sized frontal eye patches and patch on the clypeal process, which are yellow; clypeal border with two widely separated, large, blunt denticles; clypeal process with the width and length subequal, sides slightly converging and ending in denticle-like lateral extensions and the apical margin concave between the lateral extensions; mandibles with two denticles, the apical one the larger; antennae normal in form, dark fuscous.

Thorax black except for two elongate patches on the pronotum and the metanotum, which are yellow; tegulae low, smooth, and fulvous with a trace of yellow; enclosure deeply ridged longitudinally with the ridges spreading slightly apically; mesosternal tubercle absent; legs fuliginous basally over most of each femora, becoming fulvous on the tibiae and tarsi; wings subhyaline but clouded.

Abdomen black with two lateral patches on tergum 1; tergum 2 with a broad but deeply emarginate band on the posterior half; narrow lines on terga 3, 4, and 5; venter immaculate; pygidium with sides slightly convex and narrowing to a rounded apical end.

MALE.—So far indistinguishable from other closely related species. It is probably being confused with the male of *C. clypeata* Dahlbom.

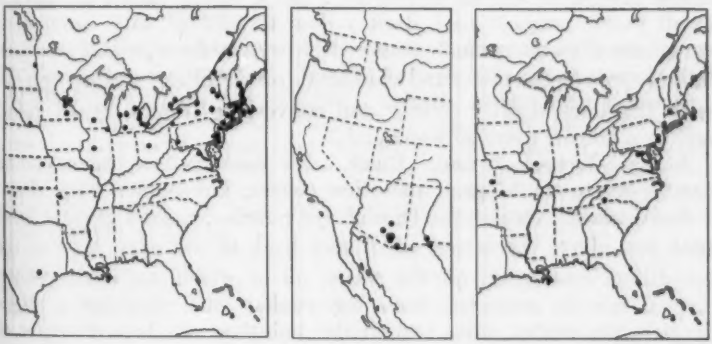
C. atramontensis Banks is very close to *C. clypeata* Dahlbom in size and color but is easily distinguished by the form of the clypeal process of the female.

TYPES.—The type female of *C. atramontensis* Banks, from Valley of Black Mountains, N.C., July 23, 1906 (Beutenmuller), is at the Museum of Comparative Zoology, Harvard, no. 21180. The type female of *C. arbuscula* Mickel, from Omaha, Nebr., July 23, 1913 (L. T. Williams), is at the University of Nebraska.

DISTRIBUTION.—North Central and Northeastern States, from eastern North Dakota to New England and south to North Carolina, Arkansas, and central Texas.

PREY RECORD.—*Conotrachelus naso* Leconte (Krombein, 1956, Virginia), *C. nenuphar* (Herbst) (J. C. Bridwell, New Hampshire). *C. posticatus* Boheman (Krombein, 1956, Virginia).

PLANT RECORD.—*Daucus carota* (New York), *Eupotorium serotinum* (Missouri), *Liriodendron tulipifera* (Virginia), *Melilotus alba* (Ohio), *Veronica apicata* (Missouri).



FIGURES 68–70.—Localities of: 68, *C. atramontensis* Banks; 69, *C. azteca* Saussure; 70, *C. banksi* Scullen.

48. *Cerceris azteca* Saussure

FIGURES 69, 151a,b,c,d

Cerceris azteca Saussure, 1867, p. 97.—Schletterer, 1887, p. 486.—Dalla Torre, 1897, p. 453.—Ashmead, 1899, p. 296.—Scullen, 1961, p. 45.
Cerceris seminigra Banks, 1947, pp. 33–34.—Scullen, 1951, p. 1010.

FEMALE.—Length 9–10 mm. Black with dark yellow, fulvous, and creamy-white markings; punctation somewhat coarser than average; pubescence very short.

Head subequal in width to the thorax; black except two medium-sized frontal eye patches, the clypeal process, spots back of the eyes, and base of mandibles, all of which are dark yellow; clypeal margin with a broad, blunt process medially flanked by single denticles approximately opposite the attachments of the sides of the clypeal process; clypeal process slightly shorter than broad, the free margin deeply emarginate and the lateral points smoothly rounded; mandibles with two denticles connected by a carina; antennae normal in form; scape and peduncle dark; flagellum dark above and fulvous below.

Thorax with prominent points on the dorsolateral angles of the pronotum; black except elongate patches on the pronotum, a divided band on the scutellum, and the tegulae, all of which are dark yellow; tegulae low and smooth; enclosure smooth except for a medial groove and a few deep pits laterally; mesosternal tubercles absent; legs black to or near the apical ends of the femora, beyond which they tend to be dark on the posterior sides and yellow on the anterior sides; wings subhyaline but clouded, becoming darker apically.

Abdomen with a creamy-white border along the lateral sides and apical margin of tergum 1; tergum 2 black except for an evanescent small patch; terga 3 to 6 dark yellow to fulvous with small dark spots laterally on tergum 3; venter dark except for a medial and two lateral spots on sternite 3 and wide bands on sternites 4 and 5; pygidium with the sides slightly convex and converging from a broad apical end to a narrow rounded basal end.

MALE.—Length 7 mm. Black with dark yellow, fulvous, and creamy-white markings; punctation coarse; pubescence very short.

Head black except large frontal eye patches, medial clypeal lobe, spot just above the latter, small spot back of the eyes, base of the mandibles, and patch on the scape, all of which are dark yellow; clypeal margin extended from the medial lobe, showing a slight denticle-like medial point and similar points at the lateral angles of the extension; hair lobes very broad, meeting at the meson, mandibles without denticles; antennae normal in form.

Thorax with prominent points on the dorsolateral angles of the pronotum; black except trace of yellow just mesad of the above points on the pronotum, a divided band on the scutellum, and most of the tegulae, all of which are yellow; tegulae chevron shaped and with scattered pits; enclosure smooth except for a medial groove and a limited number of deep pits laterally; legs black to the apical ends of femora, yellow beyond except for dark areas on the posterior sides of most segments; wings subhyaline but slightly clouded and darker at the apex.

Abdomen with a creamy-yellow border along the lateral sides and posterior border of tergum 1, tergum 2 black, terga 3 to 7 dark

yellow to fulvous with a small dark spot laterally on tergum 3; venter black with wide emarginate bands of fulvous on sternites 3, 4, and 5; pygidium with the basal end somewhat smaller than the apical end.

C. azteca Saussure closely resembles *C. dilatata* Spinola in general color pattern but belongs to a different group. The clypeal process and the wedge-shaped pygidium of the former will readily separate the females. The extremely wide hair lobes of the former will separate the males.

TYPES.—The type female of *C. azteca* Saussure is at the Naturhistorisches Museum, Vienna, Austria, with the following label: "In Agro Mexicano frequens. In partes calidas provinciae urbis Mexico prope Yautepec et Cuautla 8 ♀ in Julio cepi, et in Orizaba 2 ♀ in Martio." The type male of *C. seminigra* Banks, from Patagonia, Ariz., Aug. 20 (Bequaert), is at the Museum of Comparative Zoology, Harvard, no. 27621.

DISTRIBUTION.—This species has been taken in limited numbers in Arizona, New Mexico, and Texas, but it is more common in Mexico. Specimens are as follows:

ARIZONA: ♀, Continental, Pima Co., July 19, 1942 (H. A. Scullen); ♂, Douglas, Aug. 7, 1933 (W. W. Jones); ♂, Douglas, July 22, 1940 (W. W. Jones); ♀, 11 mi. SW. Eloy, Pinal Co., July 16, 1953 (T. R. Haig); ♂, Fort Thomas, Graham Co., 2700 ft., Aug. 7, 1946 (H. A. Scullen); ♀, Tucson, June 10, 1938 (R. H. Crandall); ♂, 10 mi. E. Tucson, July 30, 1955 (G. D. Butler); ♀, Sahuarita, July 18, 1950 (W. J. Arnold); ♀, Wilcox, Aug. 9, 1933 (Bryant). NEW MEXICO: ♀, Las Cruces, July 15, 1952 (R. H. and L. D. Beamer, C. Liang, and W. La Berge). TEXAS: 2♀♀, El Paso, July 1, 1921 (Carl Duncan); ♂, El Paso, July 14, 1942 (H. A. Scullen).

PREY RECORD.—None.

PLANT RECORD.—*Croton* (Arizona).

49. *Cerceris banksi*, new species

FIGURES 70, 152a,b,c

FEMALE.—Length 13 mm. Black with yellow markings; punctation and pubescence average.

Head slightly wider than the thorax; black except large frontal eye patches, dorsal surface of the clypeal process, small spot back of the eye, base of the mandibles, and small patch on the scape, all of which are yellow; clypeal border with a broad extension medially, to each side of which is a small denticle-like elevation; clypeal process flat with the lateral margins turned down, slightly broader than long, and the free margin emarginate with a small medial extension; mandibles with two low denticles; antennae normal in form.

Thorax black except for two widely separated patches on the pronotum, the metanotum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure smooth except for a very faint medial groove; mesosternal tubercle absent; legs fuscous to near the apical ends of all femora, beyond which they are fulvous; wings subhyaline but somewhat clouded with amber.

Abdomen with a broad but divided band on tergum 1, a broad band with variable amounts of emargination on terga 2, subequal narrower bands on terga 3 to 5; venter immaculate; pygidium with sides subparallel, ends subequal, and the apical one rounded laterally.

MALE.—Unknown. It may be confused with the males of closely related species.

From specimens named by Banks, it appears he considered this the female of *C. deserta* Say; however, it is not the female of that species (see discussion under *C. deserta* Say).

TYPES.—The type female, from Falls Church, Va., June 18 (N. Banks), is deposited at the Museum of Comparative Zoology, Harvard, no. 30447. Paratypes are as follows:

CONNECTICUT: ♀, Black Point, July 8, 1896. DISTRICT OF COLUMBIA: ♀, June 13, 1886 (T. P. Pergande). ILLINOIS: ♀, Carlingville (Charles Robertson). KANSAS: 2 ♀♀, Burbon Co., 800 ft. (R. H. Beamer). MASSACHUSETTS: ♀, Nantucket, July 16, 1926 (C. W. Johnson); ♀, Southampton, July 14, 1894. MARYLAND: ♀, Indian Hdw. [Head?], Aug. 27, 1902 (J. C. Bridwell). MISSOURI: ♀, Berry Co., June 2, 1936 (B. Frank Blair). NORTH CAROLINA: ♀, Tryon, juniper (W. F. Fiske). NEW JERSEY: ♀, Riverton, July 18, 1909 (G. M. Greene); ♀, Trenton, July 5. NEW YORK: ♀, White Plains, June 29, 1918 (J. Bequaert). VIRGINIA: ♀ (T. Pergande); ♀, July 1, 1883 (T. Pergande); ♀, Glencarlyn, July 2, *Ceanothus* (N. Banks); ♀, Rosslyn (Chittenden); 2 ♀♀ [no data].

DISTRIBUTION.—Scattered records over the Eastern States, west to Missouri.

PREY RECORD.—None.

PLANT RECORD.—None.

50a. *Cerceris bicornuta bicornuta* Guérin

FIGURES 71, 153a,b,c,d,e

Cerceris bicornuta Guérin, 1845, p. 443.—Smith, F., 1856, p. 466.—Cresson, 1865, p. 117.—Packard, 1866, p. 61.—Saussure, 1867, p. 100, pl. 4, fig. 58.—Cresson, 1872, p. 227; 1875, p. 717.—Robertson, 1887, pp. 202–216, 246.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 486.—Cameron, 1890, p. 127.—Robertson, 1891, p. 570.—Dalla Torre, 1897, p. 453.—Bridwell, 1898, p. 209.—Smith, J. B., 1900, p. 519.—Viereck, 1903, p. 120.—Viereck and Cockerell, 1904, p. 130.—Smith, J. B., 1910, p. 678.—Banks, 1912a, p. 16.—Mickel, 1917b, p. 446.—Bequaert, 1928, p. 62.—Rau, 1928, pp. 337–341, pl. 24.—Cartright, 1929, p. 35.—Scullen, 1942, p. 188.—Guiglia, 1948, p. 179.—Scullen, 1951, p. 1005.

Cerceris dufourii Guérin, 1845, p. 443.—Smith, F., 1856, p. 466.—Cresson, 1865, p. 131.—Packard, 1866, p. 64.—Cresson, 1875, p. 717; 1887, p. 282.—Schletterer, 1887, p. 490.—Dalla Torre, 1897, p. 457.—Ashmead, 1899, p. 295.—Smith, J. B., 1900, p. 519; 1910, p. 678.—Scullen, 1942, p. 188.—Guiglia, 1948, p. 179.—Scullen, 1951, p. 1005.

Cerceris venator Cresson, 1865, p. 116.—Packard, 1866, p. 61.—Cresson, 1872, p. 228; 1875, p. 717 (=*bicornuta* Guérin); 1887, p. 282.—Schletterer, 1887, p. 505.—Ashmead, 1894, p. 60.—Dalla Torre, 1897, p. 480.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Smith, J. B., 1900, p. 519.—Cockerell, 1901, p. 42.—Viereck and Cockerell, 1904, p. 130.—Viereck, 1906b, p. 223.—Smith, H. S., 1908, p. 364.—Smith, J. B., 1910, p. 678.—Mickel, 1917b p. 447.—Hendrickson, 1930, p. 160.—Scullen, 1942, p. 188; 1951, p. 1005

Cerceris curvicornis Cameron, 1890, p. 124.—Ashmead, 1899, p. 296.

Cerceris bicornis [sic] Ashmead, 1899, p. 295.

Cerceris serripes[13] Bequaert, 1928, p. 62.—Scullen, 1942, p. 188.—Strandtmann, 1945, p. 311.

Cerceris bicornuta bicornuta Krombein, 1952c, p. 336; 1953, pp. 118–119, 123, 124, 125, 134; 1954b, p. 235; 1958, p. 197; 1958b, p. 101.—Scullen, 1961, p. 45.

FEMALE.—Length 20 mm. Black, fuscous, ferruginous, and yellow infused with brown; punctation and pubescence average.

Head subequal in width to thorax; largely ferruginous with lighter, irregular frontal eye patches and black ocellar area; clypeal border with two low, broad denticles opposite the two lateral apices of the clypeal process; clypeal process low and lunar-shaped; mandibles with a medial ridge showing three indistinct, low denticle-like elevations; antennae ferruginous basally, becoming fuscous apically, normal in form.

Thorax black except the pronotum, limited patch on the scutum, the scutellum, the propodeum, and the tegulae, all of which are dark ferruginous, and the metanotum, which is yellow infused with brown; tegulae low and smooth; enclosure black and smooth except for a medial groove and pitted areas in the lateral angles; mesosternal tubercles absent; legs largely ferruginous; wings fuscous.

Abdomen dark ferruginous to fuscous except for large lateral yellow patches on terga 1 and 2; venter fuscous with the more anterior sternites somewhat lighter; denticle-like elevations appear on the posteriolateral angles of sternite 5; pygidium broader medially, the basal end a rounded point and the apical end broadly truncate.

MALE.—Length 17 mm. Black with yellow and ferruginous markings; punctation and pubescence average.

Head subequal in width to thorax; black except for face, which is yellow; clypeal border with a medial extension with three small denticles; hair lobes narrow; clypeal surface slightly convex; mandibles smooth except for a very slight indication of a single denticle; an-

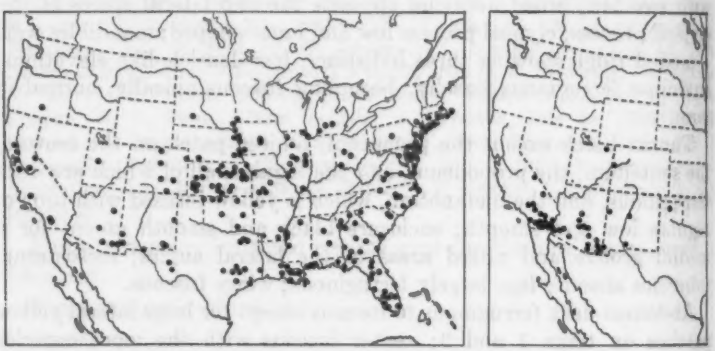
[13] See *C. serripes* Fabricius (pp. 503–505) for a discussion of its misidentification as *C. bicornuta* Guérin.

tennae with the terminal segment strongly hooked, ferruginous basally, and fuscous apically with a trace of yellow on the scape.

Thorax black except for two patches on the pronotum, the metanotum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure smooth except for a medial groove and pits in the lateral angles; mesosternal tubercles absent; legs fulvous; wings subhyaline shaded with brown.

Abdomen with tergum 1 black to fulvous; terga 2 to 6 with yellow bands variable in width and emargination, the emarginations more or less bordered with fulvous; venter dark, more or less marked with fulvous; pygidium narrowing apically and ending in a broad medial extension flanked by lateral acute denticles.

Both sexes show color pattern variation but these are more conspicuous in the females and are related geographically. The first tergum of the male varies from black to fulvous. The abdomen of the female in the nominate subspecies has the yellow confined to the large patches on the first two terga. In the subspecies *fidelis*, the entire tergum is yellow. In the extreme Southeast, the yellow on the terga disappears on most specimens.



FIGURES 71, 72.—Localities of: 71, *C. bicornuta bicornuta* Guérin; 72, *C. bicornuta fidelis* Viereck and Cockerell.

TYPES.—The type female of *C. bicornuta* Guérin and the type male of *C. dufourii* Guérin, both from New Orleans, La., are at the Museo Civico di Storia Naturale, Genoa, Italy. The type male of *C. venator* Cresson, from Illinois, is at the Philadelphia Academy of Natural Sciences, no. 1937. The type male of *C. curvicornis* Cameron, from Mexico, Presidio de Mazatlan (Forrer), is at the British Museum of Natural History, no. 21.1,430.

DISTRIBUTION.—General over most of the United States and northern Mexico. More common in the Central and Southern States.

PREY RECORD.—*Calendra* sp. (=*Sphenophorus*) (Strandtmann, 1945, Ohio), *C. aequalis* Gyllenhal (Latham, Long Island, N.Y.), *C. cariosus* (Oliver) (Krombein, 1953, North Carolina), *C. cultellatus* Horn (Missouri), *C. maidis* Chittenden (Blackman, Cartwright, 1929, South Carolina), *C. marinus* Chittenden (Latham, Long Island, N.Y.), *C. parvulus* Gyllenhal (Rau, 1928, Missouri; Latham, Long Island, N.Y.), *C. pertinax* (Oliver) (Latham, Long Island, N.Y.), *C. placidus* (Say) (Rau, 1928, Missouri), *C. setiger* Chittenden (Latham, Long Island, N.Y.), *C. venatus* (Say) (Krombein, 1953, North Carolina; Latham, Long Island, N.Y.), *C. zeae* Walsh (Rau, 1928; Latham, Long Island, N.Y.).

PLANT RECORD.—*Acacia* sp. (Texas), *Amelopsis arborea* (Louisiana, Texas), *Apocynum cannabinum* var. *pubescens* (Kansas), *Asclepias* sp. (Arizona, New Mexico, New York, Ohio), *A. verticillata* (New Mexico), *Baccharis sarothroides* (Arizona), *Cardiospermum halicacabum* (balloon vine, Texas), *Cassia* sp. (Texas), *Ceanothus* sp. (North Carolina), *Chrysothamnus* sp. (Utah), cotton (Texas), *Daucus carota* (Ohio), *Desmanthus illinoensis* (Texas), *Erigeron elongatum* (Illinois), *Eriogonum* sp. (Arizona, California), *Euphorbia marginata* (Kansas), horsemint (Texas), honey vine (Texas), hammock (Florida), *Melilotus alba* (Kansas, New Mexico, Texas), *Monarda* sp. (Texas), parsnip (Texas), *Petalostemum* sp. (Oklahoma), *P. multiflorum* (Texas), *Pluchea* sp. (North Carolina), *Quercus virginiana* (North Carolina), *Rhus* sp. (Kansas), *Sapindus drummondii* (Texas), *Salix* sp. (Texas), *Sambucus canadensis* (Ohio), *Solidago* sp. (California, Kansas, Texas), *Spiraea* sp. (North Carolina), *Tamarix* sp. (Kansas), *T. gallica* (California), *Wislizenia* sp. (Arizona), *Xanthium spinosum* (Illinois).

50b. *Cerceris bicornuta fidelis* Viereck and Cockerell

FIGURE 72

Cerceris fidelis Viereck and Cockerell, 1904, p. 132.—Banks, 1947, p. 15.
Cerceris bicornuta fidelis Scullen, 1951, p. 1005.

FEMALE.—Length 20 mm. Structurally like *C. bicornuta bicornuta* Guérin female except the colors are much lighter.

Head ferruginous on the face, ocellar area black bordered with fuscous, occiput and genae mottled with shades of brown.

Thorax variable from ferruginous to dark fuscous; pronotum with two separated, indistinct yellow patches; scutum variable shades of brown; scutellum ferruginous; metanotum fulvous to yellow; tegulae fuliginous; propodeum fulvous except the enclosure, which is dark medially but somewhat lighter in the lateral pitted area; legs ferruginous but with the lateral surfaces fulvous to yellow; wings fuscous.

Abdomen largely yellow on the terga with small ferruginous patches laterally on terga 2, 3, and 4; venter ferruginous with lateral yellow patches on sternites 2, 3, and 4.

MALE.—Length 14–15 mm. Structurally like *C. bicornuta bicornuta* Guérin but colors are lighter.

Head yellow on the face, ocellar area black, occiput and genae ferruginous.

Thorax ferruginous and yellow; pronotum with a yellow band slightly emarginate; metanotum and tegulae yellow; propodeum and enclosure ferruginous; legs ferruginous with the basal parts largely yellow; wings shaded with ferruginous.

Abdomen with the terga largely yellow except for lateral ferruginous patches on terga 2, 3, and 4; venter largely yellow emarginate or divided by ferruginous.

TYPE.—The type female of *C. fidelis* Viereck and Cockerell, from Santa Fe, N. Mex. (Cockerell), is at the Philadelphia Academy of Natural Sciences, no. 10378.

DISTRIBUTION.—Southwestern desert areas.

PREY RECORD.—*Eupagoderes* sp. (Krombein, 1959, 1960).

PLANT RECORD.—Alfalfa (Arizona, California), *Asclepias* sp. (California), *Baccharis sarothroides* (Arizona), cotton (Arizona), *Eriogonum* sp. (Arizona), *Helianthus* sp. (Arizona), *Melilotus* sp. (California), *Phacelia* sp. (California), *Sphaeralcea* sp. (Arizona), *Tamarix gallica* (California).

51. *Cerceris boharti*, new species

FIGURES 73, 154a,b,c

FEMALE.—Length 10 mm. Black with light yellow markings; punctation coarse; pubescence average.

Head slightly wider than the thorax; black except for the entire face below the antennal scrobes and basal two-thirds of the mandibles, which are light yellow; clypeal border with a medial broad extension flanked laterally by single rounded denticles; clypeal surface process in the form of a low horizontal ridge with the extremities slightly dentiform; mandibles with three low and inconspicuous elevations, the medial one the most evident; antennae normal in form.

Thorax black except for two widely separated patches on the pronotum and a divided band on the metanotum, which are light yellow; tegulae low, smooth, and fuliginous; enclosure smooth except for a medial groove; mesosternal tubercles absent; legs are black to near the apical ends of all femora, apical ends of femora are ferruginous, tibiae and tarsi are all yellow, tinged with amber except the apical end of the midtibiae and midtarsi, which are dark; wings are subhyaline with the apical margin clouded and the stigma very light.

Abdomen black except subequal medium-width bands, slightly emarginate on terga 2 to 5; venter with lateral yellow patches on sternites 3 and 4; pygidium with sides convex, apical end rounded and basal end acute.

MALE.—Unknown.

The female of *C. boharti* Scullen is very similar in size and color pattern to *C. astart* Banks and *C. krombeini* Scullen but can be separated easily from each by the clypeal structures. The form of the clypeal process of the female of *C. boharti* Scullen is very similar to that of *C. echo* Mickel but the two species are very different in other respects.

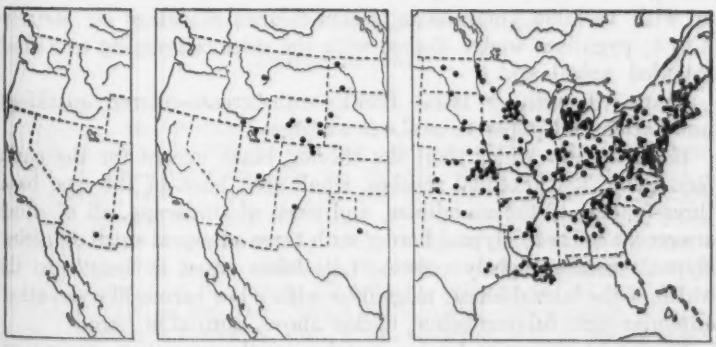
TYPES.—The type female of *C. boharti* Scullen, from Mt. Lemmon Lodge, Santa Catalina Mts., Ariz., Aug. 15, 1954 (R. M. Bohart), is at the University of California at Davis. Paratypes are as follows:

ARIZONA: ♀, Catalina Mts., 1954, *Gnaphalium* (G. D. Butler); 2♀♀, Mount Lemmon Lodge, Santa Catalina Mts., Aug. 15, 1954 (R. M. Bohart); ♀, Webber's Cabin, 7500–8500 ft., Sanata Catalina Mts., July 27, 1917; ♀, White Mts., June 19, 1950 (R. H. Beamer). NEW MEXICO: ♀, South Fork, Eagle Creek, White Mts., 8000 ft., Aug. 18 (Townsend). MEXICO: ♀, Meadow VI [June?], (Townsend).

DISTRIBUTION.—Only eight records are known, seven from the Santa Catalina Mts. and White Mts. of Arizona and New Mexico and one from Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Gnaphalium* sp. (Arizona).



FIGURES 73–75.—Localities of: 73, *C. boharti* Scullen; 74, *C. calochorti* Rohwer; 75, *C. clypeata clypeata* Dahlbom.

52. *Cerceris calochorti* Rohwer

FIGURES 74, 155a,b,c

Cerceris calochorti Rohwer, 1908, p. 322.—Scullen, 1951, p. 1006.

FEMALE.—Length 10 mm. Black with cream-colored markings; punctation and pubescence average.

Head slightly wider than the thorax; black except for the entire face below the antennal scrobes, spot back of the eye, basal three-fourths of the mandibles, and most of the scape, all of which are cream colored; clypeal border with a broad extension on the medial lobe with a sinuate margin; clypeal elevation depressed with the sides converging to a truncate end, which is emarginate and subequal in width to the length of the epistomal suture; mandibles with two distinct denticles, basad of which is a slight denticle-like elevation; antennae light fulvous below and dark above, normal in form.

Thorax black except for a divided band on the pronotum, a broad band on the scutellum, the metanotum, a large patch on each side of the propodeum, a small patch on the mesopleuron, and the tegulae, all of which are cream colored; tegulae low and smooth; enclosure with a slight but distinct medial groove and the surface entirely covered with fine striae subparallel to the meson; mesosternal tubercle absent; legs yellow except for most of the coxae, the trochanters, and the apical end of the hindfemora, which are black; wings subhyaline, slightly clouded apically.

Abdomen with a divided band on tergum 1, broad but deeply emarginate bands on terga 2 to 5; venter sometimes immaculate or with variable amounts of cream-colored markings on sternites 2 to 5; pygidium wedge shaped with the sides converging to a small rounded apical end.

MALE.—Length 9 mm. Black with cream-colored markings; punctation and pubescence about average.

Head slightly wider than the thorax, black except for the entire face below the antennal scrobes, small spot back of the eye, basal three-fourths of the mandibles, and most of the scape, all of which are cream colored; clypeal border with three subequal small denticles; clypeal surface slightly convex; hair lobes equal in length to the width of the lateral lobes; mandibles with a low carina-like elevation; antennae light fulvous below, darker above, normal in form.

Thorax black except for two patches on the pronotum, an evanescent band on the scutellum, the metanotum, large patch on each side of the propodeum, small spot on the mesopleuron, and the tegulae, all of which are cream colored; tegulae low and smooth, enclosure smooth except for a slight but distinct medial groove; mesosternal tubercle absent; legs cream colored except for dark

patches on the forecoxae, basal end of the forefemora, apical third of the hindfemora, patch on the apical end of the hindtibiae, and much of the hindtarsi; wings subhyaline but very slightly clouded apically.

Abdomen with a wide but emarginate and divided band on tergum 1, broad but deeply emarginate bands on all terga 2 to 5; venter with more or less divided, cream-colored bands on sternites 2 to 5; pygidium with side slightly convex and ends subequal in width.

The female of *C. calochorti* Rohwer is very similar in structure to the female of *C. varians* Mickel but its color markings are very much lighter. It is slightly smaller than the latter species. With more collecting between the two distributional areas, *C. varians* Mickel may in time be shown to be a subspecies of *C. calochorti* Rohwer.

TYPE.—The type female of *C. calochorti* Rohwer, from Boulder, Colo., June 27, 1905, mariposa lily (*Calochortus gunnisonii*) (W. P. Cockerell), is at the U.S. National Museum, no. 28481.

DISTRIBUTION.—This species has been taken along the eastern slope of the Rocky Mountains, from Alberta south to New Mexico and Texas.

PREY RECORD.—None.

PLANT RECORD.—*Achillea millefolium* (Wyoming), *Cleome serrulata* (Wyoming), *Calochortus gunnisonii* (Colorado), *Kuhnistera* (*Petalostemum*) *eliagophylla* (North Dakota), *Sisymbrium altissimum* (North Dakota), *Tetradymia canescens* (New Mexico), *Veratrum* sp. (Idaho).

53a. *Cerceris clypeata clypeata* Dahlbom

FIGURES 75, 156a,b,c

Cerceris clypeata Dahlbom, 1845, pp. 221, 500.—Smith, F., 1856, p. 465.—Cresson, 1865, p. 114.—Packard, 1866, p. 61.—Cresson, 1872, 229.—Provancher, 1882, p. 75, n. 2; 1883, pp. 644, 645.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 488.—Robertson, 1889, pp. 297–304.—Provancher, 1889, p. 644.—Robertson, 1890, p. 200; 1891, pp. 570, 571, 573, 575; 1893, pp. 267–274; 1894a, pp. 455, 457, 460, 462; 1896a, p. 175; 1896b, p. 72.—Dalla Torre, 1897, p. 456.—Peckham, 1898, p. 109, pl. 1, fig. 8.—Bridwell, 1898, p. 209,—Ashmead, 1899, p. 295.—Smith, J. B., 1900, p. 519.—Smith, H. S., 1908, p. 368.—Smith, J. B., 1910, p. 678.—Banks, 1912a, p. 18; 1912b, p. 107.—Viereck, 1916, pp. 695, 696.—Mickel, 1917b, p. 488.—Britton, 1920, p. 341.—Rau, 1922, p. 21.—Bischoff, 1927, p. 369.—Johnson, 1927, p. 156.—Proctor, 1938, p. 439.—Scullen, 1942, pp. 189–190.—Proctor, 1946b, p. 500.—Scullen, 1949, p. 70; 1951, p. 1006.—Krombein, 1952a, p. 181; 1952b, p. 95; 1954, pp. 6–7.—Krombein and Evans, 1954, p. 235.—Evans, 1957, p. 86, pl. 12, fig. 31.—Krombein, 1958a, p. 197.—Scullen, 1960, p. 77.

Cerceris imitator Cresson, 1865, p. 125.—Provancher, 1889, p. 450.—Ashmead, 1899, p. 295.—Smith, J. B., 1910, p. 678.—Viereck, 1916, pp. 695, 696.

Cerceris deserta Packard, 1866, p. 63.

Cerceris imitatoria Schletterer, 1887, p. 494.—Smith, H. S., 1908, p. 367.—Banks, 1912a, p. 20; 1912b, p. 107.—Mickel, 1917b, pp. 446, 449.—Britton, 1920, p. 342.—Scullen, 1951, p. 1008.

Cerceris chryssipe Banks, 1912, p. 18.—Stevens, 1917, p. 421.—Scullen, 1951, p. 1006.

Cerceris clymene Banks, 1912a, p. 20; 1912b, p. 107.—Scullen, 1951, p. 1006.

Cerceris zobeide Brimley, 1929, p. 194.—Scullen, 1951, p. 1011; 1960, p. 77.

Cerceris zosma Brimley, 1929, p. 195.—Scullen 1951, p. 1011; 1960, p. 77.

FEMALE.—Length 12 to 14 mm. Black with yellow markings; punctation and pubescence average.

Head subequal in width to the thorax; black except for large frontal eye patches, the surface of the clypeal process, base of mandibles, patch on the scape, and a small spot back of the compound eyes, all of which are yellow; clypeal border with two broad and low denticles with a depression between them; clypeal process inverted scoop shaped, with the sides subparallel or slightly converging apically; mandibles with three low denticles, the apical one being more isolated and somewhat larger; antennae normal in form.

Thorax black except for two patches on the pronotum, the metanotum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure deeply ridged subparallel to the meson; mesosternal tubercles absent; legs fuscous to black basally to near the middle of the femora, beyond which they are yellow infused with brown; wings subhyaline but clouded.

Abdomen black except for a broad band slightly emarginate on tergum 2 and narrow broken lines on the posterior margins of terga 3, 4, and 5; venter immaculate; pygidium with sides slightly converging to an apical rounded end.

MALE.—Length 10 to 12 mm. Black with yellow markings; punctation and pubescence average.

Head slightly wider than the thorax, black except the face, base of mandibles, and the scape, all of which are yellow; clypeal border with three subequal denticles on the medial lobe; surface of the clypeus convex; hair lobes limited to the lateral lobes of the clypeus; mandibles with the inner margin slightly sinuate without distinct denticles; antennae with the terminal segment slightly curved.

Thorax black except for two patches on the pronotum, the metanotum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure deeply ridged parallel to the meson; mesosternal tubercles absent; forelegs dark to the femora, beyond which they are mostly yellow; midlegs largely yellow with darker areas; hindlegs largely yellow to middle of the femora, beyond which they are largely dark; wings subhyaline but slightly clouded.

Abdomen black except for a broad band on tergum 2 and narrow broken lines on terga 3 to 6; venter black to dark fuscous with small

yellow spots appearing laterally on sternites 2, 3, and 4; pygidium with sides slightly convex and with the apical end slightly convex.

C. clypeata Dahlbom and its closely related forms have presented a difficult problem to taxonomic workers. Banks was inclined to consider slight variations as characters on which to establish new species. On the other hand, some students were inclined to bring together closely related forms that the present writer prefers to keep distinct. The correct identification of some males is still uncertain. Only exhaustive field studies can clear up this problem.

C. imitator Cresson (new name *C. imitatoria* Schletterer), which was described from Illinois, appears to be a male *C. clypeata* Dahlbom, with the band on the second tergite somewhat narrower than on the typical *clypeata* male.

The writer has studied the types of *C. clypeata* Dahlbom at Lund, and he finds the typical forms of this species clearly defined.

TYPES.—The type female and allotype male of *C. clypeata* Dahlbom, labeled "America," are at the Universitets Zoologiska Institution, Lund, Sweden. The type male of *C. imitator* Cresson, from Illinois, is at the Philadelphia Academy of Natural Sciences, no. 1951. The type female and the allotype male of *C. chryssipe* Banks, from Falls Church, Va., are at the Museum of Comparative Zoology, Harvard, no. 13791. The type female and allotype male of *C. clymene* Banks, from Glencarlyn, Va., and Falls Church, Va., are also at the Museum of Comparative Zoology, Harvard, no. 13789. The type male of *C. zobeide* Brimley and the type female of *C. zosma* Brimley, both collected at Raleigh by C. S. Brimley, are at the North Carolina State Department of Agriculture, Raleigh, N.C.

DISTRIBUTION.—Through the Eastern States and southeast Canada. It is common west to eastern Nebraska and Kansas. One female and two males are recorded from Colorado. Limited specimens have been seen from the southeastern Gulf States.

PREY RECORD.—*Balaninus nasicus* Say (Peckham, 1898, Wisconsin), *Chalepus dorsalis* Thunberg (Krombein, 1954, West Virginia), *Lema trilineata* Oliver (Chrysomelidae) (K. W. Cooper, New Jersey; F. Kurczewski, Virginia); *Pissodes strobi* (Peck) (K. W. Cooper, New Jersey); *Tanymecus confusus* (Say) (Bridwell, Washington, D.C.).

PLANT RECORD.—*Acacia* (Texas), *Ambrosia artemisiaefolia* (Kentucky), *Angelica* sp. (Colorado), *Asclepias* sp. (Connecticut, Massachusetts), *Asclepias comuti* (Illinois), *Asclepias incarnata* (Illinois) *Asclepias sulliventii* (Illinois). *Asclepias tuberosa* (Georgia), *Asclepias verticillata* (Illinois, Iowa), *Aster ericoides* (Illinois), *Berteroa incana* (Massachusetts), *Ceanothus* sp. (Virginia), *Ceanothus americanus* (Illinois, New York, Virginia), *Chrysanthemum leucanthemum* (North Carolina), *Cicuta* sp. (Virginia), *Cicuta maculata* (Ohio), cotton

(Alabama), *Daucus carota* (Massachusetts, New York, Ohio), dogbane (=*Apocynum* sp.; New Hampshire), *Erechtites hieracifolia* (New Jersey), *Euphorbia marginata* (Kansas), *Euthamia graminifolia* (New Jersey), *Helianthus divaricatus* (North Carolina) horsemint (Texas), *Hydrangea arborescens* (North Carolina), *Leucanthemum* sp. (North Carolina), *Melilotus alba* (Iowa, Kansas, Massachusetts, Tennessee), *Monarda didyma* (North Carolina), peach (Georgia), *Polygonum cuspidatum* (Massachusetts), *Polygonum pensylvanicum* (Illinois), *Rhus glabra* (Maryland), *Sambucus canadensis* (Ohio), *Solidago* (Connecticut, Massashusetts, New York, North Carolina, Pennsylvania, Virginia), *Solidago canadensis* (Illinois, New York), *Solidago serotina* (North Dakota), *Symphoricarpos racemosus* (Ohio).

53b. *Cerceris clypeata dakotensis* Banks, new status

FIGURES 76, 157a,b,c

Cerceris dakotensis Banks, 1915, p. 402.—Stevens, 1917, p. 422.—Scullen, 1951, p. 1007.

FEMALE.—Length 11 to 12 mm. Black with light yellow markings; punctation and pubescence average.

Head subequal in width to the thorax; black except for large frontal eye patches, surface of the clypeal process, base of mandibles, round spots back of the eyes, and the scape, all of which are yellow; clypeal border with two broad and low denticles with a depression between them; clypeal process with the sides converging to a near truncate apical end, which is very slightly emarginate; mandibles with three low denticles, the apical one being more isolated and somewhat larger; antennae normal in form.

Thorax black except for two elongate patches on the pronotum, the metanotum, oval patches on the propodeum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure heavily ridged transversally; mesosternal tubercle absent; legs with the coxae and trochanters fuliginous on all legs, the basal half of the femora of the fore- and midlegs also fuliginous and the more apical parts of all legs yellow; wings subhyaline but slightly clouded.

Abdomen with lateral yellow patches on tergum 1, a broad band very slightly emarginate on tergum 2, deeply emarginate bands on terga 3, 4, and 5; venter immaculate except for lateral yellow patches on sternite 3; pygidium with sides slightly convex and converging to a rounded apical end.

MALE.—Indistinguishable from the males of *C. clypeata clypeata* Dahlbom.

The female of *C. clypeata dakotensis* Banks is very close to *C. clypeata clypeata* Dahlbom, from which the former is separated by the form of its clypeal process.

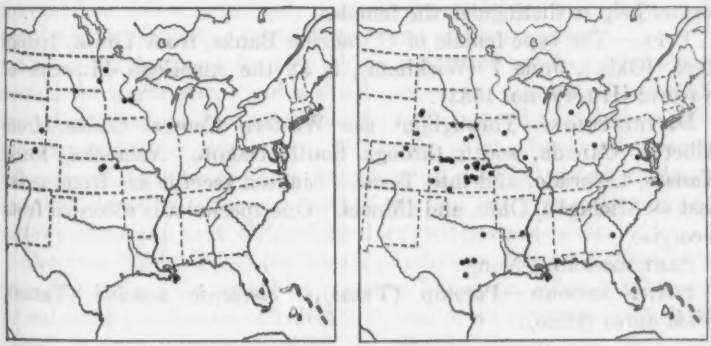
TYPES.—The type female and allotype male of *C. dakotensis* Banks, from Fargo, N. Dak., July 7, Sept. 6 (Stevens), are at the Museum of Comparative Zoology, Harvard, no. 13770.

DISTRIBUTION.—North Central States. Specimens are as follows:

COLORADO: ♀, Fort Collins, July 18, 1938 (M. T. James). ILLINOIS: ♀, White Heath, June 14, 1925 (Beardsley). KANSAS: ♀, Blackjack Creek, Pottawatomie Co., 1954 (H. E. and M. A. Evans); ♀, Leavenworth Co., July 1, 1924 (E. P. Breakey); ♀, Riley Co., Sept. 11 (J. B. Norton). MINNESOTA: ♀, Midland Hills Golf Club, Ramsey Co., Aug. 30, 1921 (Arthur Hertig); ♀, Polk Co., Aug. 16, 1924 (Walter Carter); ♀, St. Anthony Park, Ramsey Co., Sept. 14, 1924 (Walter Carter); ♀, Wright Co., Aug. 5, 1936 (S. S. Easter). MONTANA: ♀ [no other data]. NEBRASKA: ♀, Halsey, Aug. 4, 1948 (R. R. Dreisbach); ♀, Omaha, June 25, 1913, alfalfa (L. T. Williams). NORTH DAKOTA: ♀, Fargo, Aug. 25, 1918, *Solidago canadensis* (O. A. Stevens). SOUTH DAKOTA: ♀, Mobridge, Aug. 15, 1924. UTAH: ♀, Provo, July 6, 1922 (E. P. Van Duzee). WISCONSIN: ♀, Genoa, July 7–12, 1911. WYOMING: ♀, Wheatland, Sept. 3, 1954 (Don Fronk).

PREY RECORD.—None.

PLANT RECORD.—*Melilotus alba* (North Dakota), *Solidago canadensis* (North Dakota), *Solidago serotina* (North Dakota).



FIGURES 76, 77.—Localities of: 76, *C. clypeata dakotensis* Banks; 77, *C. clypeata gnarina* Banks.

53c. *Cerceris clypeata gnarina* Banks, new status

FIGURES 77, 158a,b,c

Cerceris gnarina Banks, 1913a, p. 237.—Scullen, 1951, 1008.

FEMALE.—Length 12 to 14 mm. Black with yellow markings; punctation and pubescence average.

Head subequal in width to the thorax; black except for large frontal eye patches, large patch on clypeal process, spots back of compound eyes, and base of mandibles, all of which are yellow; clypeal border with two large, blunt denticles, between which is a broad, deep depression continuous with a depression below the clypeal process;

clypeal process large, inverted scoop shaped; mandibles with one prominent denticle and a very low divided denticle more basad; antennae normal in form.

Thorax black except for two elongate patches on the pronotum and the metanotum, which are yellow; tegulae low, smooth, and fulvous; enclosure lightly ridged in the lateral angles and with a light medial groove; mesosternal tubercles absent; legs fulvous; wings subhyaline but clouded.

Abdomen with broad yellow bands on the first two terga; the band on tergum 1 is semidivided medially; the 3rd and rarely the 4th tergum may show remnants of yellow lines on the posterior border at the lateral extremities; venter immaculate; pygidium with the sides converging to a rounded apical end.

MALE.—Indistinguishable.

C. clypeata gnarina Banks is very close to *C. clypeata clypeata* Dahlbom. The size of the former is noticeably larger, the clypeal process more rugged and more rounded on its margins. These characters and the heavy yellow band on the first tergite of the former help to distinguish the females.

TYPE.—The type female of *C. gnarina* Banks, from Vinita, Indian Terr. [Okla.], June 7 (Wickham), is at the American Museum of Natural History, no. 15837.

DISTRIBUTION.—Throughout the Western Central States, from Alberta, Canada, south through South Dakota, Nebraska, Iowa, Kansas, Colorado, and into Texas. Limited records are from as far east as Michigan, Ohio, and Illinois. One specimen is recorded from Georgia.

PREY RECORD.—None.

PLANT RECORD.—Parsnip (Texas), *Polytaenia nuttallii* (Texas), *Zizia aurea* (Ohio).

53d. *Cerceris clypeata prominens* Banks, new status

FIGURES 78, 159a,b,c

Cerceris prominens Banks, 1912a, p. 19.—Scullen, 1942, p. 188; 1951, p. 1010.
Cerceris alaope Banks, 1912a, p. 22; 1912b, p. 107.—Scullen, 1942, p. 188.

FEMALE.—Length 13 mm. Black with yellow markings; punctation and pubescence average.

Head slightly wider than the thorax; black except for two large frontal eye patches, patch on the clypeal process, small spot back of compound eye, base of mandible, and the scape, all of which are yellow; clypeal border with two low, broad denticles, between which is a single, medial broad lamella; clypeal process longer than broad, convex above; mandibles with three denticles, the more apical one

the largest, the others small and fused at the base; antennae normal in form, nearly black beyond the scape.

Thorax black except for two elongate patches on the pronotum, the metanotum, and patch on the propodeum, all of which are yellow; tegulae low, smooth, and amber in color; enclosure ridged longitudinally; mesosternal tubercles absent; legs largely yellow infused with brown, basal segments very dark; wings subhyaline, slightly clouded.

Abdomen black except for a divided band on tergum 1, a wide but deeply emarginate band on tergum 2, narrow bands on terga 3, 4, and 5; venter immaculate; pygidium with sides slightly convex and converging to a rounded apical end.

MALE.—Length 13 mm. Body colors black with yellow markings, legs with considerable amber; punctation somewhat coarse and crowded; pubescence average.

Head about one-seventh wider than the thorax; black except the entire face, basal half of mandibles, and two basal segments of the antennae, all of which are yellow; clypeal border with three distinct dark fuscous denticles on the medial lobe; clypeal surface only slightly convex; hair lobes cover only lateral clypeal lobes; mandibles with two denticles; antennae with the terminal segment curved.

Thorax black except for two widely separated patches on the pronotum, the metanotum, and a small spot on the tegulae, all of which are yellow; tegulae low and smooth; enclosure with a deep medial groove and lateral ridges at a 45° angle to the base; mesosternal tubercles absent; basal three segments of all legs yellow ventrally and dark dorsally, tibiae and tarsi of the first two pair of legs largely yellow; tibiae and tarsi of hindlegs dark; wings subhyaline.

Abdomen black except for lateral patches on tergum 1, broad but emarginate band on tergum 2, narrow bands on terga 3 to 6 and lateral small patches on sternites 2, 3, and 4, all of which are yellow; pygidium with sides subparallel but slightly convex and ends subequal in width.

C. clypeata prominens Banks is close to *C. clypeata clypeata* Dahlbom, from which the former is separated by the more deeply emarginate band on its second tergum. Some border line specimens may remain uncertain. The males are more difficult to separate than the females. The females of *C. atramontensis* Banks and *C. clypeata gnarina* Banks are also very close but easily separated by the characters given in the key.

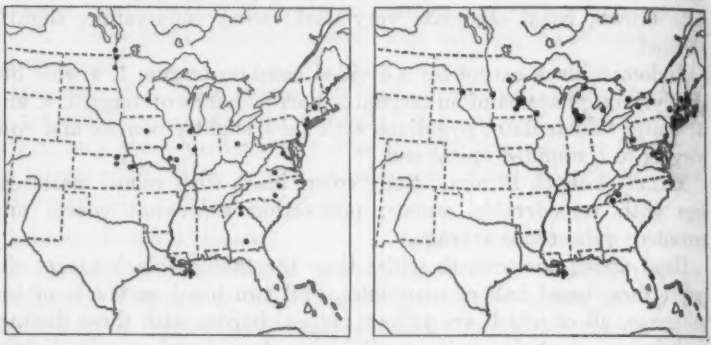
TYPES.—The type female and allotype male of *C. prominens* Banks, from Falls Church, Va., September and October, are at the Museum of Comparative Zoology, Harvard, no. 13790. The type female and allotype male of *C. alaope* Banks, also from Falls Church,

Va., are at the Museum of Comparative Zoology, Harvard, no. 13784.

DISTRIBUTION.—Throughout the Eastern States, south to the Gulf of Mexico and west to Minnesota, Iowa, and Kansas.

PREY RECORD.—None.

PLANT RECORD.—*Asclepias* sp. (Ohio), *Melilotus alba* (Kansas).



FIGURES 78, 79.—Localities of: 78, *C. clypeata prominens* Banks; 79, *C. dentifrons* Cresson.

54. *Cerceris dentifrons* Cresson

FIGURES 79, 160a,b,c

Cerceris dentifrons Cresson, 1865, p. 124.—Packard, 1866, p. 63.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 489.—Dalla Torre, 1897, p. 457.—Ashmead, 1899, p. 295.—Smith, J. B., 1900, p. 519; 1910, p. 678.—Banks, 1912a, p. 18.—Viereck, 1916, p. 696.—Stevens, 1917, p. 422.—Mickel, 1917b, p. 448.—Johnson, 1927, p. 156.—Proctor, 1938, p. 439; 1946, p. 500.—Scullen, 1951, p. 1007.

FEMALE.—Length 8 mm. Black with light yellow markings; punctation close and deep; pubescence very short.

Head slightly wider than the thorax; black except for large frontal eye patches and the clypeal process, all of which are yellow; clypeal margin slightly extended with denticle-like extensions at the lateral apices; clypeal process lunate with the points very acute; mandibles with two adjoining medial denticles; dark fuscous except for a yellow area at the base; antennae normal in form, dark fuscous.

Thorax black except for two patches on the pronotum, the metanotum, small patches on the propodeum, and the tegulae, all of which are light yellow; tegulae low and smooth; enclosure deeply ridged longitudinally; mesosternal tubercles absent; legs fuscous to near the apical ends of the femora, beyond which they become ferruginous with darker patches on the midtibiae; wings subhyaline.

Abdomen with a doubly indented band on tergum 1, a deeply emarginate band on tergum 2, and narrow, slightly emarginate bands

on terga 3, 4, and 5; venter immaculate; pygidium with sides converging to a round apical end.

The color markings vary some in the shade of yellow and in their extent. The clypeal process easily distinguishes this small eastern species.

MALE.—Unknown.

TYPE.—The type female of *C. dentifrons* Cresson, from Illinois, is at the Philadelphia Academy of Natural Sciences, no. 1942.1.

DISTRIBUTION.—Scattered records throughout the Northeastern States, from South Dakota to New England, north of the Ohio River and the Washington, D.C., area.

PREY RECORD.—None.

PLANT RECORD.—*Solidago rigida* (North Dakota).

55. *Cerceris deserta* Say

FIGURES 80, 161a,b,c,d,e

Cerceris deserta Say, 1825, p. 344.—Smith, F., 1856, p. 465.—Cresson, 1865, p. 125.—Packard, 1866, p. 63.—Cresson, 1876, pp. 206–211.—Provancher, 1882, p. 76; 1883, p. 465.—LeConte, 1883, p. 232.—Taylor, 1884, p. 80.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 489.—Provancher, 1889, p. 645.—Ashmead, 1890, p. 32.—Dalla Torre, 1897, p. 457.—Peckham, 1898, p. 115.—Bridwell, 1898, p. 209.—Smith, J. B., 1900, p. 519.—Viereck, 1906, p. 397.—Smith, H. S., 1908, p. 367.—Smith, J. B., 1910, p. 678.—Banks, 1912a, p. 18; 1912b, p. 107.—Viereck, 1916, p. 695.—Mickel, 1917b, p. 449.—Britton, 1920, p. 341.—Bischoff, 1927, p. 369.—Viereck, 1928, p. 196.—Scullen, 1942, p. 187.—Strickland, 1947, pp. 121–130.—Scullen, 1951, p. 1007.

Cerceris fulvipes Cresson, 1865, p. 126.—Packard, 1866, p. 63.—Patton, 1879, p. 360.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 492 (*fulvipediculata* nomen nudum).—Robertson, 1894, pp. 453, 455; 1896, p. 175.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Smith, J. B., 1910, p. 678.—Scullen, 1942, p. 187.

Cerceris fulvipediculata Schletterer, 1887, p. 492.—Smith, H. S., 1908, p. 369.—Banks, 1912a, p. 24.—Viereck, 1916, p. 695.—Stevens, 1917, p. 422.—Mickel, 1917b, p. 451.—Viereck, 1920, p. 342.

FEMALE.—Length 10 mm. Black with creamy-yellow to white markings; punctation and pubescence average.

Head slightly wider than the thorax; black except for two large frontal eye patches, a bilobed patch on the clypeal elevation, large patch back of the compound eye, and the basal half of the mandibles, all of which are creamy white; clypeal border with five denticles, the medial one with a medial depression above and the two lateral denticles much smaller than the second pair; clypeal elevation reduced to a characteristic bilobed, distended area; mandibles with three small denticles, becoming progressively larger toward the apical one, beyond which there is a carina; antennae fulvous below and fuscous above, normal in form.

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Thorax black except for two patches on the pronotum, the metanotum, a large patch on the propodeum, a minute spot on the pleuron, and a patch on the tegulae, all of which are creamy white to creamy yellow; the tegulae low and smooth; enclosure with a medial groove and the surface lightly ridged medially, parallel to the meson, and with heavier ridges near the lateral angles at about 45° to the base; mesosternal tubercles absent; legs fulvous with limited yellow patches, wings subhyaline, slightly clouded at the apical border.

Abdomen black with subequal bands of creamy white on all terga 1 to 5 except that the band on tergum 1 is divided medially; venter with variable patches of creamy white laterally on sternites 2 to 5; pygidium with the sides slightly convex, the apical end rounded and the basal end slightly broader and not rounded.

MALE.—Length 10 mm. Black with yellow and creamy-white markings; punctation and pubescence average.

Head slightly wider than the thorax; black with the exception of the entire face, spot back of the eye, basal half of the mandibles, and the scape, all of which are yellow; clypeal border with three widely separated denticles; clypeal surface with a very characteristic ridge just above the border extending the full width of the medial lobe, above which is a prominent flat area; hair lobes short, extending from the eyes over about two-thirds of the distance to the lateral clypeal denticles; mandibles with a broad sinuate carina; antennae normal in form.

Thorax black except for two patches on the pronotum, the metanotum, patch on the propodeum, and the tegulae, all of which are light yellow; tegulae low and smooth; enclosure with a medial groove, moderately ridged with the ridges spreading apically; mesosternal tubercle absent; legs largely yellow with the apical end of the hindfemora fuscous and fuscous patches on the fore- and midfemora and the hindtibiae.

Abdomen black with two separated patches on tergum 1 and subequal narrow bands on terga 2 to 6, slightly emarginate, which are creamy white; venter with wedge-shaped, creamy-white patches on sternites 2 to 5; pygidium with sides slightly converging apically to a semitruncate end.

Several earlier workers appear to differ in their identification of the male of *C. deserta* Say, on which the species was established. Also there apparently has been some misidentification of the female of the species. The present writer bases his recognition of the male on the following facts: (1) A specimen labeled "Neotype" in the Museum of Comparative Zoology, Harvard, is the species herein recognized as *deserta* Say; it is assumed this "Neotype" label was placed on the specimen by Banks. (2) The species as

accepted by the present writer runs to *deserta* Say in Bank's key (1912a, p. 13); however, not all of the specimens determined by Banks agree with the above "Neotype." (3) A specimen in the Philadelphia Academy of Natural Sciences determined by Cresson agrees with the one the writer calls *deserta* Say. (4) Unpublished notes by S. A. Rohwer indicate he accepted Cresson's determinations at Philadelphia as correct. (5) A male specimen determined by Viereck indicates he agrees with the present writer in the form accepted as *deserta* Say.

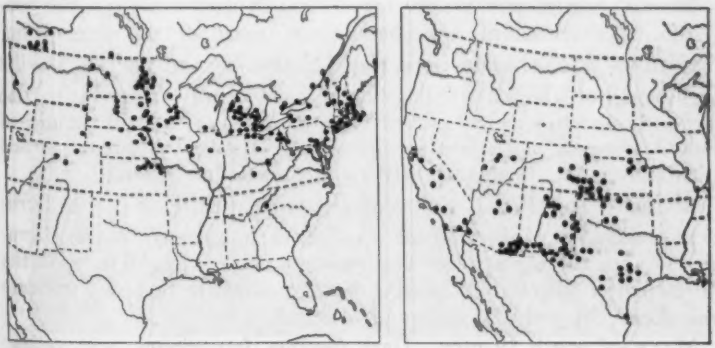
In the writer's paper (1942, p. 187), he called attention to the fact that *C. fulvipes* Cresson is the female of *C. deserta* Say.

TYPES.—The writer is accepting the male specimen labeled "Neotype," from South Dakota, Aug. 20 [locality and year illegible], at the Museum of Comparative Zoology, Harvard, no. 31,113, as authentic by Banks. The original type material, which apparently has been lost, is recorded from "N. West Territory, Mo., Pa." The female type of *C. fulvipes* Cresson, from Delaware, is at the Philadelphia Academy of Natural Sciences, no. 1941.

DISTRIBUTION.—Throughout the North Central and Northeastern States.

PREY RECORD.—The Peckhams (1898) record *C. deserta* Say as taking *Conotrachelus posticatus* Boheman (Curculionidae); however, because some workers have differed in the identification of *C. deserta* Say, this record needs verification. No other prey records have been found by the writer.

PLANT RECORD.—*Aster* sp. (Kansas), *Eupatorium* sp. (Kentucky), *Grindelia* sp. (North Dakota), *Melilotus alba* (North Dakota), *Polygonum* sp. (Kansas), *Solidago* sp. (Connecticut, Kansas, Massachu-



FIGURES 80, 81.—Localities of: 80, *C. deserta* Say; 81, *C. frontata frontata* Say.

setts, North Dakota, New Hampshire, New York), *Solidago canadensis* (Minnesota), *Solidago rigida* (Minnesota, North Dakota), yarrow (New York).

56a. *Cerceris frontata frontata* Say

FIGURES 81, 162a,b,c, 183a,b; PLATE 1

Cerceris frontata Say, 1823, p. 80.—LeConte, 1883, p. 167.—Cresson, 1865, p. 129.—Packard, 1866, p. 64.—Cresson, 1875, p. 717; 1887, p. 282.—Schletterer, 1887, p. 492.—Dalla Torre, 1897, p. 461.—Ashmead, 1899, p. 295.—Viereck and Cockerell, 1904, p. 130.—Banks, 1912a, p. 16.—Mickel, 1917b, p. 447.—Banks, 1947, p. 9.—Scullen, 1951, p. 1008; 1961, pp. 46–47.

Cerceris texensis Saussure, 1867, p. 89.—Schletterer, 1887, p. 504.—Dalla Torre, 1897, p. 478.—Scullen, 1951, p. 1010.

Cerceris occidentalis Saussure, 1867, p. 100.—Schletterer, 1887, p. 498.—Dalla Torre, 1897, p. 469.—Scullen, 1951, p. 1009.

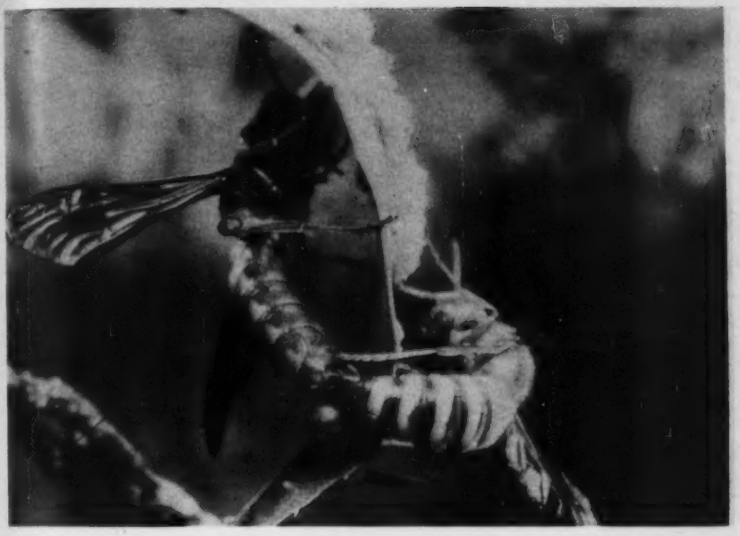
FEMALE.—Length 25 mm. Ferruginous with dull yellow markings; punctation and pubescence normal.

Head somewhat wider than the thorax; largely dull yellow with a ferruginous area extending through the ocellar area between the compound eyes, a ferruginous line connecting the vertex of the eyes with a like-colored area on the occiput; clypeal border with two separated, prominent, blunt denticles; laterad of each a much smaller denticle; above each of the larger denticles a cluster of prominent bristles, laterad of which is a row of shorter bristles decreasing in length toward and extending to the mandibles; clypeal process lunar shaped but with considerable variations in the angle of expansion in different specimens; a prominent row of closely packed bristles extends along the concave margin of the process between the two points; mandibles dull yellow at the base, becoming dark fuscous toward the tip with two widely separated small denticles; antennae normal in form with the scape dull yellow and the flagellum becoming dark fuscous apically.

Thorax ferruginous except for a semidivided band on the pronotum, the scutellum, the metanotum, most of the propodeum, divided patch on the enclosure, elevated areas on the pleuron, and the tegulae, all of which are dull yellow infused with ferruginous; tegulae low and smooth; enclosure relatively smooth except for a slight medial groove; mesosternal tubercles absent; legs largely dull yellow infused with ferruginous; wings slightly clouded with ferruginous.

Abdomen largely dull yellow on the terga with more or less ferruginous along the anterior margins of each tergum; venter ferruginous with the elevated areas somewhat lighter; pygidium with the sides slightly convex, the basal end much narrower than the truncate apical end, fringed with a row of bristles.

MALE.—Length 19 mm. Dark fuscous, ferruginous, and yellow; closely punctate; pubescence somewhat longer than average.



C. frontata frontata Say (top and bottom): copulating pair on *Baccharis glutinosa*, two miles northeast of Portal, Ariz., July 28, 1961, photographed by Martin A. Mortenson (photo courtesy Southwest Research Station, Portal, Ariz.).

Head slightly wider than the thorax, face yellow below antennal scrobes, dark fuscous on the vertex and occiput, with a ferruginous patch back of the ocelli, genae mostly ferruginous with a small yellow spot in the upper area; clypeal border with three denticles, the medial one somewhat more prominent; clypeal surface slightly convex; mandibles slightly sinuate but without distinct denticles; antennae ferruginous, becoming fuscous apically, terminal segments blunt and slightly curved.

Thorax dark fuscous on the mesonotum, enclosure, and depressed areas on the pleuron and venter; pronotum with a yellow band deeply emarginate with a wedge-shaped ferruginous area; scutellum, metanotum, patches on the propodeum, and the tegulae yellow infused with ferruginous; other parts largely ferruginous; tegulae low and smooth; enclosure relatively smooth except for a medial groove and limited punctation along the lateral margin; mesosternal tubercles absent; legs yellow and ferruginous; first metatarsal segment long and straight on the hindleg; wings subhyaline tinged with ferruginous.

Abdomen has the first tergum ferruginous with lateral yellow patches, terga 2 to 5 with broad yellow bands slightly emarginate with ferruginous, tergum 6 largely yellow; venter largely ferruginous with deeply emarginate or broken bands on sternites 2, 3, and 4; pygidium with sides very slightly convex and the basal end noticeably broader than the truncate apical end.

Superficially, there is considerable similarity between *C. frontata* Say and *C. bicornuta* Guérin; however, they may be separated readily by the clypeal processes of the females and by the first tarsal segments of the hindlegs of the males. There is a marked variation within the species, varying both in size and color in the same locality. The background color of the male, for example, may vary from ferruginous to fuscous. The females may vary nearly as much. Western species in general are lighter than eastern species. In the Bay Area in California the species also become somewhat darker. The males vary in length from 13 to 20 mm., and the females, from 15 to 22 mm. The much darker and somewhat larger forms of the northeastern range are recognized as a subspecies, *C. frontata ravi* Rohwer.

Types.—Say's types appear to have been lost. *C. frontata* Say was described from Arkansas. From the description, the type appears to have been a lighter form. A neotype female, from 19 mi. E. of Lordsburg, N. Mex., 4600 ft., Aug. 1, 1946 (H. A. Scullen), designated by the writer, is deposited at the U.S. National Museum. The type female of *C. occidentalis* Saussure and the type female of *C. texensis* Saussure were not found in Vienna or Geneva. A male at the Museum d' Histoire Naturelle, Geneva, determined by Saussure as *C. texensis* Saussure was considered a representative of that species.

A female of *C. occidentalis* Saussure, designated a lectotype by the writer, is at the Museum d' Histoire Naturelle, Geneva. Both of the above were typical lighter forms of *C. frontata* Say and were from Texas. This is our largest species of *Cerceris* in North America.

DISTRIBUTION.—Throughout the South Central States and the Southwest, from southern Illinois, southern Nebraska, Colorado, Utah, and central California, south into Mexico.

PREY RECORDS.—*Lixus mucidus* LeConte (California; Curculionidae), *Eupagoderes* sp., and *Cleonus pulvereus* LeConte (Krombein, 1960b, Portal, Ariz.).

PLANT RECORD.—*Acacia* sp. (Arizona), *A. augustissima* (Arizona), *Ampelopsis arborea* (Texas), *Ascelpias* sp. (Arizona, New Mexico, Mexico, and Texas), *A. speciosa* (Utah), *A. subverticillata* (Arizona), *Baccharis* sp. (Arizona, Mexico), *B. glutinosa* (Arizona, Mexico), *Baileya pleniradiata* (Arizona), *Eriogonum* sp. (California), *E. thomasii* (Arizona), *Gutierrezia sarothrae* (Arizona), *Lepidium* sp. (Arizona), *Melilotus alba* (Arizona, Kansas, New Mexico), *Mimosa* sp. (Arizona), parsnip (Texas), *Petalostemum multiflorum* (Texas), *Salsola pestifer* (Utah), *Solidago* sp. (Kansas), *Spindus saponari* (Arizona).

56b. *Cerceris frontata raui* Rohwer

FIGURE 82

Cerceris raui Rohwer, 1920, p. 230.—Rau, 1922, p. 21; 1928, pp. 325–337.—Scullen, 1951, p. 1010.
Cerceris frontata raui Scullen, 1960, p. 80.

FEMALE.—Length 20 mm. Structurally like *C. frontata frontata* Say but considerably darker.

Head dark ferruginous with the antennal and ocellar areas dark fuscous.

Thorax black and dark ferruginous; metanotum and tegulae yellow; yellow may also appear on the propodeum and the scutellum; legs dark ferruginous; wings heavily clouded with ferruginous.

Abdomen largely dark ferruginous; yellow bands on terga 3 to 6 deeply emarginate or broken into two lateral patches; venter rufo-ferruginous.

MALE.—Length 17 mm. Structurally like the male of *C. frontata frontata* Say but with yellow markings much more limited.

Head black except the face yellow and small amber spots back of the eyes.

Thorax black except for two patches on the pronotum, two spots on the scutellum, the metanotum, and the tegulae, all of which are yellow infused with ferruginous; legs ferruginous and yellow; wings lightly clouded with ferruginous.

Abdomen with the first tergum ferruginous, second tergum with a broad yellow band deeply emarginate with ferruginous and anterior border black; terga 3, 4, and 5 with a yellow band deeply emarginate with fuscous; tergum 6 fuscous with a trace of yellow; venter light fuscous with the more elevated areas lighter and with traces of yellow on sternites 2 and 3.

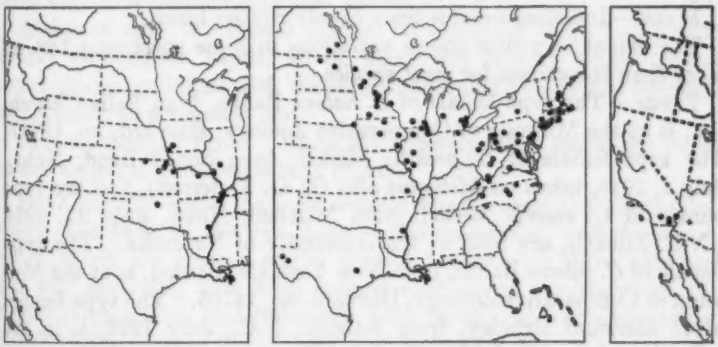
As in *C. frontata frontata* Say, the subspecies *raui* Rohwer is variable in its color intensity.

TYPES.—The type female and allotype male of *C. raui* Rohwer, from near St. Louis, Mo. (Phil Rau), are in the U.S. National Museum, no. 21610.

DISTRIBUTION.—Southern Iowa, southern Illinois, Missouri, eastern Kansas, northeastern Texas, Oklahoma, and Arkansas.

PREY RECORD.—The nesting and feeding habits of this subspecies were described by Phil Rau (1922, 1928), who found them using *Lixus concavus* Say (rhubarb curculio) and *Thecesternus humeralis* (Say) near St. Louis.

PLANT RECORD.—*Avicennia nitida* (Texas), *Cuscuta* sp. (Kansas), *Euphorbia marginata* (Kansas).



FIGURES 82–84.—Localities of: 82, *C. frontata raui* Rohwer; 83, *C. halone* Banks; 84, *C. macswaini* Scullen.

57. *Cerceris halone* Banks

FIGURES 83, 163a,b,c

Cerceris halone Banks, 1912a, p. 24.—Stevens, 1917, p. 422.—Scullen, 1951, p. 1008; 1960, p. 78.—Byers, 1962, pp. 317–321.

Cerceris architis Mickel, 1916, p. 409; 1917b, p. 450.—Abbott, 1928, pp. 205, 206.—Scullen, 1951, p. 1005.—Krombein, 1958a, p. 197.

Cerceris alacris Mickel, 1917a, pp. 333, 334, 452.—Scullen, 1951, p. 1005 (new synonymy).—Krombein, 1958a, p. 197.

Cerceris salome Banks, 1923, p. 21.

Cerceris shermani Brimley, 1928, p. 200.

FEMALE.—Length 13 to 15 mm. Black with yellow markings; punctation and pubescence average.

Head slightly wider than the thorax; black except for most of the face below the antennal scrobes, small spots back of the compound eyes, base of mandibles, and patch on the scape, all of which are yellow; clypeal border with two very large angular denticles with a depression between them; clypeal process broader than long with the margin lunar shaped; mandibles with a prominent medial denticle and a more basal smaller one; antennae normal in form and dark amber.

Thorax black except for two separated patches on the pronotum, the metanotum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure heavily ridged, becoming irregular in some specimens; mesosternal tubercle absent; legs dark basally, becoming yellow amber on the more apical parts of the femora and beyond; wings slightly clouded.

Abdomen with tergum 1 showing two lateral patches, tergum 2 with a broad band deeply emarginate anteriorly, terga 3, 4, and 5 with narrow bands, all of which are yellow; venter dark amber; pygidium with sides slightly converging apically to a truncate end.

MALE.—Indistinguishable from closely related forms.

The extent of yellow shows variations in some specimens but no more than is common for most species.

TYPES.—The type female of *C. halone* Banks, from Falls Church, Va., is at the Museum of Comparative Zoology, Harvard, no. 13777. The type female of *C. architis* Mickel, from South Bend, Nebr., July 2, 1915, taken on *Melilotus alba* (E. G. Anderson), and the type female of *C. alacris* Mickel, from Mitchell, Nebr., July 21, 1916 (C. E. Mickel), are both at the University of Nebraska. The type female of *C. salome* Banks, from New York (N. Banks), is at the Museum of Comparative Zoology, Harvard, no. 14705. The type female of *C. shermani* Brimley, from Raleigh, N.C., July 1929, is in the collection of the North Carolina State Department of Agriculture.

DISTRIBUTION.—Through the Eastern States, south to South Carolina and west to North Dakota, Nebraska, Kansas, and Texas.

PREY RECORD.—*Curculio affinis* (?) (Virginia), *C. confusor* Hamilton (Virginia), *C. iowensis* Casey (Minnesota, Virginia), *C. nasicus* Say (Abbot, 1928, Minnesota; Illinois; Byers, from Virginia), *C. rectus* (Say) (Krombein, 1958).

PARASITE RECORD.—*Hedychrum violaceum* Brullé (Chrysididae) (Bridwell).

PLANT RECORD.—*Melilotus alba* (Nebraska), *Rhus glabra* (New Mexico), *Solidago* sp. (North Carolina, Kansas), *S. altissima* (New Jersey), *S. canadensis* (New York).

58. *Cerceris macswaini*, new species

FIGURES 84, 164a,b,c

FEMALE.—Length 10 mm. Black with creamy-white markings; punctation average; pubescence very short.

Head slightly wider than the thorax; black except for large frontal eye patches, the medial lobe of the clypeus, small patches on the lateral clypeal lobes, large spot back of the eye, and the base of the mandibles, all of which are creamy white; clypeal border with two blunt lateral denticles and a divided medial one; clypeal process broader than long and with the apex emarginate; mandibles with two distinct denticles, the apical one slightly the larger; antennae normal in form and largely ferruginous.

Thorax black except for a divided band on the pronotum, the metanotum, a large patch on the propodeum, a spot on the pleuron, and a spot on the tegulae, all of which are creamy white; tegulae low and smooth; enclosure heavily ridged longitudinally with the apical ends of the ridges spreading; mesosternal tubercles very inconspicuous; legs largely dark fuscous except for creamy-white patches near the apical ends of the first two pair of femora; wings subhyaline with the usual clouded area near the apex.

Abdomen with two lateral patches on tergum 1, terga 2 to 5 with deeply emarginate bands, all of which are creamy white; venter immaculate; pygidium with the sides subparallel basally but converging apically to a rounded end.

MALE.—Length 9 mm. Black with creamy-white markings; punctation average; pubescence very short.

Head slightly wider than the thorax; black except the entire face, small spot back of the eye, base of the mandibles, and the scape, all of which are creamy white; clypeal border with three subequal but low denticles; hair lobes extend over about two-thirds of the lateral clypeal lobe; mandibles with little more than a sinuate carina; flagellum ferruginous below, becoming darker above.

Thorax black except for a broken band on the pronotum, the metanotum, a large patch on the propodeum, a small evanescent spot on the pleuron, and the tegulae, all of which are creamy white; tegulae low and smooth; enclosure variably ridged; mesosternal tubercle absent; legs largely creamy white except for dark patches near the basal end of the first two pair of femora, the apical one-third of the third pair of femora, a patch on the apical end of the hind pair of tibiae, and the apical segments of the hind pair of tarsi; wings subhyaline with the usual apical clouded area.

Abdomen black except for two lateral patches on tergum 1, broad but deeply emarginate bands on terga 2 to 6; venter with lateral

triangular patches on sternites 2 to 5; pygidium sides very slightly convex, ends subequal in width, the apical end very slightly convex.

The male of *C. macswaini* Scullen is almost indistinguishable from the male of *C. calochorti* Rohwer. The enclosure of the former usually is ridged considerably while that of the latter is smooth except for the usual medial groove. So far, the known geographical ranges do not overlap.

TYPES.—The type female and allotype male of *C. macswaini* Scullen, from Imperial Co., Calif., June 1911 (J. C. Bridwell), are deposited at the U.S. National Museum, no. 67731. Paratypes are as follows:

ARIZONA: ♀ (C. F. Baker). CALIFORNIA: 41 ♀ ♀, 61 ♂ ♂, Imperial Co., May, June 1911 (J. C. Bridwell); 2 ♀ ♀, 2 ♂ ♂, Imperial Co., June 1912 (J. C. Bridwell); 16 ♀ ♀, 6 ♂ ♂, Experiment Farm, Imperial Co., June 1912 (J. C. Bridwell); 3 ♀ ♀, Blythe, Riverside Co., June 14, 1945 (E. G. Linsley); 3 ♀ ♀, Blythe, July 20, 30, 1947 (J. W. Macswain); ♀, Holtville, Imperial Co., Aug. 11, 1917 (J. Bequaert); 3 ♀ ♀, Palm Springs, Riverside Co., June 22, 1945.

DISTRIBUTION.—This species is known only from southern California and adjoining Arizona.

PREY RECORD.—None.

PLANT RECORD.—*Baccharis glutinosa, Hyptis emory, Tamarix fallica* (all from California).

59. *Cerceris melanthe* Banks

FIGURES 85, 165a,b,c

Cerceris melanthe Banks, 1947, pp. 21–22.—Scullen, 1951, p. 1009.

FEMALE.—Length 6 to 10 mm. Black with yellow markings; punctation coarse; pubescence average.

Head subequal in width to the thorax; black except for the entire face below the antennal scrobes, a small spot back of the compound eye, and base of the manidibles, all of which are yellow; the clypeal border (here considered the lower of two parallel rows of denticle-like processes) consists of a broad medial tridentate process, to each side of which is an indistinct denticle; clypeal elevations (here considered the upper of the two parallel rows of denticles) consists of three denticles, the medial one small and very acute and the two lateral ones somewhat larger and rounded apically; the two parallel rows of elevations are separated by a depression that is black including the two rows of denticles; mandibles with one large denticle, basad of which is a much smaller denticle; antennae normal in form.

Thorax black except for a divided band on the pronotum, the metanotum, a small patch on the propodeum, and the tegulae, all of

which are yellow; tegulae low and smooth; enclosure with a medial groove and scattered small punctation over much of the surface; mesosternal tubercle minute; legs fuscous except the hindtrochanter and most parts beyond the femora, all of which are yellow; wings subhyaline, becoming cloudy apically.

Abdomen with a narrow semidivided band on tergum 1, a broad band very slightly emarginate on tergum 2, narrower and deeply emarginate bands on terga 3, 4, and 5; venter black except for lateral yellow patches on sternites 3 and 4; pygidium with sides convex, the apical end rounded and the basal end acute.

MALE.—Unknown.

C. melanthe Banks closely resembles *C. nitida* Banks, which has been taken in Texas. The two females can be separated by the clypeal denticles and the bicolored hindfemora of the latter species. The former has not been taken east of New Mexico.

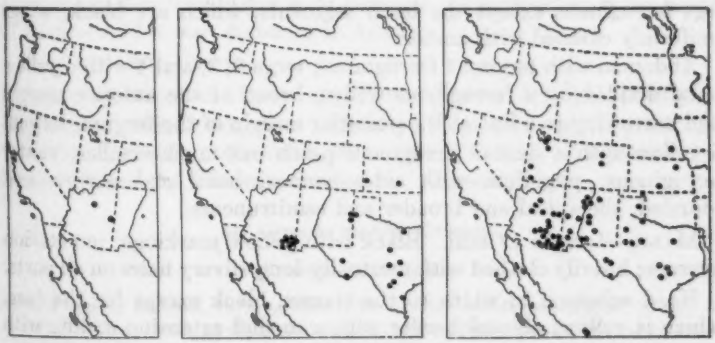
TYPE.—The type of female of *C. melanthe* Banks, from Apache Co., Santa Catalina Mts., Ariz., July 25, 5500 feet (J. Bequaert), is at the Museum of Comparative Zoology, Harvard, no. 23539.

DISTRIBUTION.—Arizona and New Mexico. Specimens are as follows:

ARIZONA: 4 ♀ ♀, S. Arizona, August 1902 (F. H. Snow); 5 ♀ ♀, Oak Creek Canyon, 6000 ft., July, August 1902 (F. H. Snow); ♀, same locality, Aug. 9, 1932 (R. H. Beamer); ♀, same locality, Aug. 27, 1947 (L. D. Beamer). NEW MEXICO: ♀, Willow Creek, Sept. 4, 1933 (G. E. Bohart).

PREY RECORD.—None.

PLANT RECORD.—None.



FIGURES 85–87.—Localities of: 85, *C. melanthe* Banks; 86, *C. mimica* Cresson; 87, *C. morata* Cresson.

60. *Cerceris mimica* Cresson

FIGURES 86, 166a,b,c,d

Cerceris mimica Cresson, 1872, p. 288; 1887, p. 282.—Schletterer, 1887, p. 497.—Dalla Torre, 1897, p. 467.—Ashmead, 1899, p. 295.—Banks, 1912a, pp. 13, 14.—Scullen, 1951, p. 1009; 1961, p. 47.

Cerceris esau Schletterer, 1887, p. 458.—Dalla Torre, 1887, p. 459.—Ashmead, 1899, p. 296.

Cerceris minima [sic] Schletterer, 1887, p. 497.

Cerceris englehardti Banks, 1947, pp. 12, 13.

FEMALE.—Length 18 mm. Black, ferruginous, and yellow; punctation average; pubescence much longer and darker than average.

Head subequal in width to the thorax; ferruginous except for a large black patch covering the antennal and ocellar areas, and the following parts, which are yellow: large eye patches, patch between the antennae, small patches on the lateral clypeal wings, most of the clypeus, basal part of the mandibles; basal segments of the antennae amber; apical parts of the mandibles and antennae very dark; clypeal margin with two divided extensions, below which is a medial rounded extension; these margin extensions are heavily screened from above by amber bristles; clypeal surface process shorter than broad with two lateral denticle-like points connected by a low carina; prominent short bristles cover the area below the carina; mandibles with two distinct but low denticles; antennae normal in form.

Thorax black, except for semidivided band on the pronotum, the scutellum, and the metanotum, all of which are ferruginous; tegulae low and smooth; enclosure with a medial groove and deeply pitted except the central third at the base; mesosternal tubercles absent; legs ferruginous except the basal segments, which are black; wings uniformly clouded with amber.

Abdomen with tergum 1 ferruginous; terga 2, 3, and 4 with a yellow band divided by a ferruginous wedge, broad at the anterior margin and narrowing to a line at the posterior margin of the tergum; tergum 5 yellow with a similar ferruginous patch but much smaller; venter ferruginous; pygidium with sides convex, basal end narrow and rounded, the apical end broader and semitruncate.

MALE.—Length 17 mm. Black with yellow markings; punctation average; heavily clothed with unusually long silvery hairs on all parts.

Head subequal in width to the thorax, black except for the face, which is yellow; clypeal border with a medial extension ending with three subequal distinct denticles; an unusually prominent carina between the antennae; mandibles with one small denticle-like elevation near the center; antennae dark with basal segments black and shiny.

Thorax black except for two widely separated patches on the

pronotum, tegulae low, smooth, and with a trace of amber; enclosure with a medial groove and pitted except for the central third at the base; mesosternal tubercles absent; legs black to dark amber with traces of yellow basally to or near the apical ends of the femora; tibiae yellow with dark areas; tarsi largely yellow; wings subhyaline.

Abdomen with tergum 1 black, terga 2 to 5 with wedge-shaped lateral yellow patches narrowing to the medial line but not quite meeting, tergum 6 with widely separated patches; venter black with variable traces of yellow laterally; prominent and heavy clusters of brownish bristles laterally on each sternite; pygidium with sides almost straight but converging slightly apically, with the apical end truncate, clothed with short, scattered bristles.

The male of *C. mimica* Cresson closely resembles the male of *C. bicornuta* Guérin. The bristles on the venter of the former and the S-shaped first hindtarsal segment of the latter species easily separates them. The male of *C. mimica* Cresson also closely resembles the male of *C. verticalis* F. Smith, from which the former can be separated by the form of the pygidium and the lack of bristles on the venter of the latter.

TYPES.—The type female of *C. mimica* Cresson, from Texas, is at the Philadelphia Academy of Natural Sciences, no. 1943. The lectotype female of *C. esau* Schletterer, from Mexico, is at the Naturhistorisches Museum, Vienna. The type male of *C. englehardti* Banks, from St. John, Ariz., July 27, 1931 (G. P. Englehardt), is at the Museum of Comparative Zoology, Harvard, no. 27638.

DISTRIBUTION.—*C. mimica* Cresson has been taken through the Southern States from Arizona to Florida. It is recorded as far north as Kansas and is also common in Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Asclepias* sp. (New Mexico, Arizona), *Asclepias subverticillata* (Arizona, New Mexico), *Baccharis* sp. (Texas), *B. glutinosa* (Arizona), *Condalia obtusifolia* (Texas), *Eriogonum* sp. (Arizona), parsnip (Texas), *Solidago* sp. (Kansas).

61. *Cerceris morata* Cresson

FIGURES 87, 167a,b,c

Cerceris morata Cresson, 1872, p. 230; 1887, p. 282.—Schletterer, 1887, p. 497.—Dalla Torre, 1897, p. 468.—Ashmead, 1899, p. 295.—Banks, 1912a, p. 19.—Scullen, 1942, p. 188; 1951, p. 1009.

Cerceris nasica Viereck and Cockerell, 1904, p. 132.—Viereck, 1906b, pp. 233, 239.—Banks, 1947, p. 20.—Scullen, 1942, p. 188.

FEMALE.—Length 14 mm. Black, yellow, and ferruginous; punctation and pubescence average.

Head slightly wider than the thorax; most of the face below antennal scrobes, base of mandibles, spots back of compound eyes, and the scape, all yellow; vertex, genae, occiput, medial clypeal lobe below the process, apical part of the process, medial segments of the antennae, all ferruginous; frons black to fuscous; clypeal border with two large, blunt denticles, between which is a deep depression; clypeal process prominent, convex with sides subparallel, the apical margin concave, and the lateral apical points acute; mandibles with three denticles, the more apical one very large and the more basic pair small and close together; antennae normal in form.

Thorax black except for a broad band on the pronotum, the scutellum, and the tegulae, all of which are ferruginous; and the metanotum and patches on the propodeum, which are yellow, the latter bordered with ferruginous; tegulae low and smooth; enclosure moderately ridged longitudinally; mesosternal tubercles absent; legs ferruginous; wings subhyaline, lightly shaded with ferruginous.

Abdomen with the terga largely yellow but with areas of ferruginous appearing medially on some terga and darker emarginations on the anterior borders of most terga; venter largely ferruginous with yellow patches laterally on sternites 2 to 5; pygidium with the sides slightly convex and converging to a rounded apical end.

MALE.—Length 11 to 12 mm. Black with yellow and ferruginous markings; punctation average; pubescence somewhat longer than average.

Head slightly wider than the thorax; face yellow except for the free margin of the clypeus, which is amber; remainder of the head black except for a yellow spot back of the eye and a mottled ferruginous area extending from one gena through the occiput to the other gena and embodying the yellow spots back of the eyes; clypeal margin with three subequal denticles on the medial lobe; hair lobes subequal in length to the lateral lobes; mandibles with one small but distinct medial denticle, basad of which there is a low sinuate carina; antennae normal in form except for the apical segment, which is blunt and curved; scape yellow and the remaining segments ferruginous, becoming darker apically.

Thorax black except for a divided band on the pronotum, the scutellum, the metanotum, a large patch on the propodeum, and the tegulae, all of which are yellow and, in the case of the pronotum band and the scutellum, bordered with ferruginous; tegulae low and smooth; enclosure with a medial groove and variably ridged with the ridges spreading posteriorly; mesosternal tubercles absent; legs yellow except the dorsal surfaces of the first two pair of femora and the apical parts of the hindlegs beyond the middle of the femora, all of which are

ferruginous; a darker area may appear on the dorsal surface of the third femora; wings subhyaline with a clouded area on the apex.

Abdomen with the darker parts more or less ferruginous and the markings yellow; tergum 1 with lateral yellow patches; tergum 2 with a broad yellow band and a slight emargination of ferruginous; terga 3, 4, and 5 yellow with broad and deep emarginations of ferruginous, tergum 6 largely yellow; venter largely dark ferruginous with emarginate bands of yellow on sternites 2 to 5, and traces of yellow on 6; pygidium with sides slightly diverging apically and the apical end broadly rounded.

The principal variation is the extent of the colors. This is especially true with the terga, where the yellow may cover the terga completely or be deeply emarginate.

C. morata Cresson is close to *C. vicina* Cresson. The females may be separated by the form of the clypeal process. The males are indistinguishable where their ranges overlap.

C. morata Cresson also is related closely to *C. clypeata* Dahlbom, which it replaces in the South Central States. It possibly should be considered a subspecies of *C. clypeata* Dahlbom.

TYPES.—The type female of *C. morata* Cresson, from Texas (Belfrage), is at the Philadelphia Academy of Natural Sciences, no. 1944. The type female of *C. nasica* Viereck and Cockerell, from New Mexico (F. H. Snow), is at the Philadelphia Academy of Natural Sciences, no. 10382.

DISTRIBUTION.—*C. morata* Cresson has been taken mostly in Texas, New Mexico, and Arizona. It is recorded as far north as Utah and Kansas and south into Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Asclepias latifolia* (Texas), cotton (Arizona), *Lepidium* sp. (Arizona), *Melilotus alba* (Kansas), *Wislizenia* sp. (Arizona), *Zizyphus lycioides* (Arizona).

62. *Cerceris nebrascensis* H.S. Smith

FIGURES 88, 168a,b,c

Cerceris nebrascensis H. S. Smith, 1908, p. 368.—Mickel, 1917b, p. 451.—Scullen, 1951, p. 1009.

FEMALE.—Length 10 to 12 mm. Black with creamy-yellow and fulvous markings; punctation average; pubescence very short.

Head subequal in width to thorax; black except for large frontal eye patches, large patch on the clypeal process, and base of mandibles, all of which are creamy yellow; clypeal border with four denticles, the medial pair being indistinct; clypeal process slightly longer than broad with the free apical margin slightly emarginate; mandibles

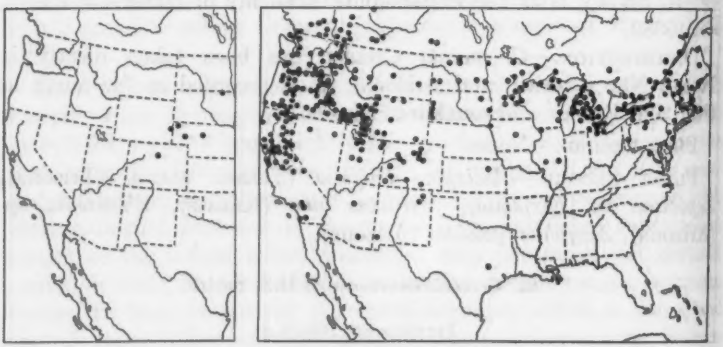
with three closely appressed denticles, the apical one much the larger and the basal one very inconspicuous; antenna normal in form and largely fulvous.

Thorax black except for two widely separated patches on the pronotum and the metanotum, which are creamy yellow; tegulae low, smooth, and fulvous in color; enclosure heavily ridged longitudinally; mesosternal tubercles absent; legs fulvous; wings subhyaline but clouded with fulvous.

Abdomen with the first segment largely fulvous with a semidivided creamy-yellow band on the tergum, terga 2 to 5 with subequal creamy-yellow bands broadly emarginate; venter immaculate; pygidium with sides slightly convex and converging to a narrower rounded apical end.

MALE.—Positive identification still uncertain.

Specimens of females examined show considerable variation in the form of the clypeal process. *C. nebrascensis* is related closely to *C. nigrescens* F. Smith, but the fulvous color readily distinguishes the former from the latter species. *C. nebrascensis* is very close to *C. wyomingensis* Scullen in size, general color pattern, and distribution, but the form of the clypeal process easily separates them; however, in both species the clypeal process shows considerable variation in form.



FIGURES 88, 89.—Localities of: 88, *C. nebrascensis* H. S. Smith; 89, *C. nigrescens nigrescens* F. Smith.

TYPE.—The type female and one paratype male, both from Glen, Sioux Co., Nebr., 4000 ft., Aug. 15, 1906, are at the University of Nebraska.

DISTRIBUTION.—This rare species has been taken only in the North Central States as indicated by the following records. Specimens are as follows:

COLORADO: ♀, Boulder Co., Sept. 10, 1926 (C. P. Custer). NEBRASKA: ♀, Halsey, Aug. 12, 1925 (L. C. Worley); ♀, Sand Hills, Sept. ; ♀, Glen, Sioux Co., 4000 ft., Aug. 12, 1906 (P. R. Jones). SOUTH DAKOTA: ♀, Hecla, July 26, 1928 (H. C. Severin). WYOMING: ♀, Torrington, Sept. 20, 1939 (J. Standich).

PREY RECORD.—None.

PLANT RECORD.—*Solidago serotina* (Nebraska).

63a. *Cerceris nigrescens nigrescens* F. Smith

FIGURES 89, 169a,b,c,d

Cerceris nigrescens F. Smith, 1856, p. 466.—Cresson, 1865, p. 123.—Packard, 1866, p. 62; 1872, p. 230.—Provancher, 1882, p. 75; 1883, pp. 643, 644.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 497.—Provancher, 1889, p. 643.—Dalla Torre, 1897, p. 468.—Peckham, 1898, p. 116, pl. 8, fig. 6.—Ashmead, 1899, p. 295.—Viereck and Cockerell, 1904, p. 138.—Banks, 1912a, p. 20.—Stevens, 1917, p. 422.—Mickel, 1917b, p. 450.—Carter, 1925, p. 133.—Bischoff, 1927, p. 208.—Krombein, 1936, pp. 94, 95; 1938, pp. 1–3.—Banks, 1947, p. 18.—Scullen, 1951, p. 1009.—Evans, 1957, p. 85, pl. 41, figs. 27–29.—Scullen, 1960, p. 79.

FEMALE.—Length 12 mm. Black with cream-colored markings; punctation somewhat less than average; pubescence short.

Head slightly wider than the thorax; black except large frontal eye patches, dorsal surface of the clypeal process, patch between the antennal scrobes, spots back of the compound eyes, base of mandibles, and small spot on the scape, all of which are cream colored; clypeal border extended on the medial lobe and forming lateral denticles, between which is a broad projection consisting of lateral carina connected by a thiner lamella; clypeal process convex above, slightly broader than long, emarginate with the lateral points rounded; mandibles with three small denticles, the apical one the most acute and larger, the basal one low and broad, all fused at the base; antennae normal in form, dark above, light below with a small yellow spot on the scape.

Thorax black except for two widely separated patches on the pronotum, the metanotum, and patches on the tegulae, all of which are cream colored; tegulae low and smooth; enclosure deeply ridged longitudinally, but the ridges tending to spread apically; mesosternal tubercle absent; legs dark to about the apical end of all femora, tibiae dark above and cream below, tarsi cream with darkened areas; wings subhyaline clouded with amber, darker toward the apex.

Abdomen black except for two separated patches on tergum 1, narrow bands on terga 2 to 5, all of which are cream colored; venter immaculate; pygidium with the sides strongly converging apically to a narrow rounded point.

MALE.—Length 10 mm. Black with cream-colored to creamy-yellow markings; punctation and pubescence average.

Head slightly wider than the thorax; black except entire face, small spot back of compound eye, base of mandible, and patch on the scape, all of which are cream colored; clypeal margin with three low denticles, the medial one sometimes slightly divided, all usually low and often indistinct; clypeal surface slightly convex; mandibles with a rounded extension medially on the lower margin; antennae with the apical segment slightly curved.

Thorax black except for two elongate, widely separated patches on the pronotum, the metanotum, and the tegulae, all of which are cream colored; tegulae low and smooth; enclosure lightly ridged longitudinally but somewhat irregular; mesosternal tubercles absent; legs with the first two pair largely yellow except dark patches on the dorsal sides of the femora; the hindlegs yellow except the apical half of the femora, a patch on the apical end of the tibiae, and small patches on the tarsi, all of which are dark amber; wings subhyaline with the stigma light.

Abdomen black except for two separated patches on tergum 1, narrow bands on terga 3 to 6, divided bands on sternites 2, 3, and 4, all of which are cream colored; pygidium with the sides subparallel and the apical end truncate.

C. nigrescens nigrescens F. Smith is close to the following species in general appearance: *astarte* Banks and *dentifrons* Cresson in the Eastern States. In the West it is near *C. aequalis* Provancher. The form of the clypeal process and the pygidium usually will separate them. The cream-colored markings of the nominate subspecies also will aid in its recognition. In the Pacific Coast States the cream-colored markings gradually are replaced with yellow. Mating pairs may be found in southern Oregon, where one sex has yellow markings and one, cream-colored markings. Some individuals show varying amounts of cream and yellow. In California *C. nigrescens munda* Mickel, the yellow form, predominates.

TYPE.—The type female of *C. nigrescens* F. Smith, from Nova Scotia, is in the British Museum, no. 21.1,431.

DISTRIBUTION.—This is the most widely distributed species of *Cerceris* in North America. It ranges from New England west through the Northern States to the Pacific Coast and south to Nevada, Utah, Colorado, Nebraska, Iowa, Illinois, Ohio, and North Carolina. It is recorded also from Alaska. As indicated above, the subspecies *munda* Mickel largely takes over in California.

PREY RECORD.—*Hyperodes solutus* (Boheman) (New York), *H. delumbis* Gyllenhal (Krombein, 1936, 1938, New York), *Sitona hispidulus* (Fabricius) (Krombein, 1936, 1938, New York), *Gymnetron antirrhini* Paykull (Krombein, 1938, New York).

PLANT RECORD.—*Achillea* sp. (California, Idaho, New York, Oregon), *A. millefolium* (Wyoming), alfalfa (Alberta, Idaho, Oregon),

Angelica (Minnesota), *Anthemis cotula* (Idaho), *Apocynum androsaemifolium* (Quebec, Canada), *Aralia hispida* (Vermont), *Asclepias* sp. (California, Idaho), *A. mexicana* (California), asparagus (Idaho), beans (Idaho), *Berteroa incana* (Massachusetts), blackeyes (Colorado), *Brassica nigra* (Utah), Canada thistle (Oregon), carrots (California, Idaho, New York, Oregon), *Ceanothus americanus* (Massachusetts, Quebec, Canada), *C. canadensis* (Massachusetts), *C. fendleri* (Arizona), *Chrysothamnus* sp. (California, Idaho, Oregon, Washington), *C. leucanthemum* (New York, North Carolina), *C. viscidiflorus* ssp. *typicus* (California), *Cicuta maculata* (Ohio), *Cirsium* sp. (Idaho), *Cirsium lanceolatum* (British Columbia, Canada), *Cleome* sp. (Idaho), *C. lutea* (Oregon), *C. serrulata* (Oregon), clover (Idaho, Oregon), *Conium maculatum* (Oregon, Utah), corn (Idaho), *Croton californicas* (California), daisy (New York), *Daucus carota* (New York, Oregon), *Epilobium angustifolium* (Idaho, Alaska), *Eriogonum* sp. (Oregon), *E. fasciculatum* (California), *E. fasciculatum* v. *polifolium* (California), *E. nudum* (California), *E. ovalifolium* (Utah), evening primrose (minute) (California), *Grindelia squarrosa* (Utah), *Holodiscus discolor* (Oregon), honeysuckle (Saskatchewan, Canada), *Ilex verticillata* (Quebec, Canada), *Lotus americanus* (California), matta beets (Idaho), *Melilotus* sp. (sweet clover) (Idaho, Oregon, South Dakota, Washington), *Melilotus alba* (Iowa, California), parsnips (Idaho), *Philadelphus coronarius* (New York), *Polygonum* sp. (Colorado), *Polygonum auberti* (California), potatoes (Idaho, Oregon), *Potentilla* (California), rose (Illinois), rudbeckia (Idaho), *Salix* sp. (Colorado), *Salix exigua* (California), *Senecio cymbalarioides* (Colorado), *S. platylobus* (Utah), wild snapdragon (Idaho), *Solidago* sp. (British Columbia, Canada, Colorado, Idaho, Massachusetts, New York, North Dakota, Oregon, Utah, Washington), *Solidago canadensis* (New Mexico), *S. elongata* (Oregon), *Sonchus arvensis* (Idaho), *Sophia pestifer* (Idaho), *S. sophia* (Idaho), spearmint (British Columbia, Utah), sumac (Wisconsin), *Symphoricarpos occidentalis* (North Dakota), *S. racemosus* (British Columbia, Canada), *Tanacetum vulgare* (Michigan), tansy (British Columbia, Canada), Umbelliferae (Utah), *Veratrum* (Idaho), vetch (Utah), water hemlock (Idaho, Oregon), yarrow (New York, Oregon, Utah).

63b. *Cerceris nigrescens arelate* Banks, new status

FIGURES 90, 170a,b,c

Cerceris arelate Banks, 1912a, p. 18.—Proctor, 1938, part VI, p. 439; 1946, part VII, p. 500.—Viereck, 1916, p. 696.—Scullen, 1951, p. 1005.
Cerceris nigritulus Banks, 1915, p. 402.—Scullen, 1951, p. 1009 (new synonymy).
Cerceris crawfordi Brimley, 1928, p. 199.—Scullen, 1951, p. 1007 (new synonymy).

FEMALE.—Length 10 mm. Black with yellow markings; punctation and pubescence average.

Head subequal in width to the thorax; black except frontal eye patches, clypeal process, base of mandibles, small spot above the process, and small spot back of the eyes, all of which are yellow; clypeal border extended from the medial lobe, showing broad, blunt denticles at the lateral angles of the extension and a much smaller medial denticle; clypeal process of the inverted scoop type but subequal in width and length, deeply emarginate with the lateral points very acute; mandibles with three denticles, the most apical one larger and separated from the two basal denticles, which are joined at their bases and subequal in size; antennae dark, normal in form.

Thorax black except for two widely separated spots on the pronotum, the metanotum, and small patch on the tegulae, all of which are yellow; tegulae low and smooth; enclosure rugose, with the ridges extending longitudinally; mesosternal tubercle absent; legs dark to or near the apical end of the femora of all legs, beyond which they are mostly yellow; wings subhyaline but clouded in the apical area; stigma medium dark; pygidium with the sides converging to a rounded apical end.

Abdomen with subequal bands on all terga 1 to 5 except that on tergum 1 it is divided at the meson; venter immaculate; pygidium with sides slightly converging to a rounded apical end.

MALE.—The subspecies *C. nigrescens arelate* Banks is structurally close to *C. nigrescens nigrescens* F. Smith except for the lighter markings, which are yellow, the lateral clypeal denticles, which are more prominent, and the usual absence of light markings on the tergum and the venter of the former.

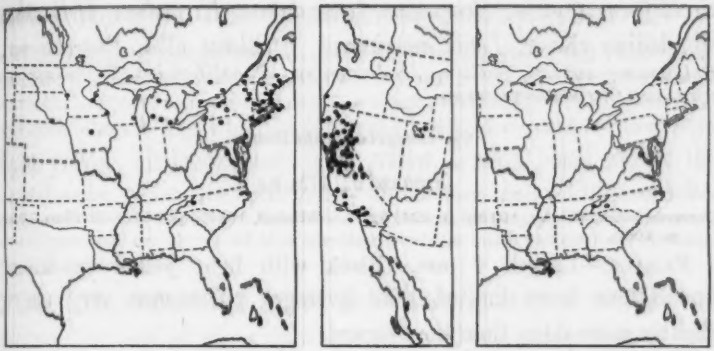
The female of *C. nigrescens arelate* Banks is very near in form and color to the female of *C. nigrescens nigrescens* F. Smith, from which the former is separated by the form of its clypeal process and the very acute lateral points of its process. The latter is inclined to have the markings somewhat creamy yellow in the typical form found in the northeast, while *C. nigrescens arelate* Banks has bright yellow markings.

TYPES.—The type female of *C. arelate* Banks, from Great Falls, Va., June 20, is at the Museum of Comparative Zoology, Harvard, no. 13779. The type male of *C. nigritulus* Banks, from Colden, N.Y., July 3 (M. C. Van Duzee), is at the Museum of Comparative Zoology, Harvard, no. 13782. The type male of *C. crawfordi* Brimley, from Raleigh, N.C., July 1928, is in the collection of the North Carolina State Department of Agriculture, Raleigh, N.C.

DISTRIBUTION.—Through the Northeastern States and southeastern Canada, west to Minnesota and south to Virginia.

PREY RECORD.—None.

PLANT RECORD.—None.



FIGURES 90–92.—Localities of: 90, *C. nigrescens arelate* Banks; 91, *C. nigrescens munda* Mickel; 92, *C. nitida* Banks.

63c. *Cerceris nigrescens munda* Mickel

FIGURES 91, 171a,b,c

Cerceris munda Mickel, 1917a, p. 337.—Banks, 1947, p. 18.—Scullen, 1951, p. 1009; 1960, p. 79.

Cerceris abbreviata Banks, 1919, p. 84; 1947, p. 17.

FEMALE.—Structurally close to *C. nigrescens nigrescens* F. Smith. Markings yellow and often more extended than in the typical subspecies, especially noticeable in the amount of yellow on the venter and the hindfemora. As indicated, the yellow forms take over in southern Oregon and become the dominating form in California; however, the yellow form has been taken in Washington, where the type of *C. abbreviata* Banks was taken.

MALE.—As in the female, the male of the subspecies *munda* differs from the typical form only in the more yellow markings.

The subspecies *C. nigrescens munda* Mickel is very close to *C. aequalis aequalis* Provancher, which is also confined largely to California. The principal difference is in the form of the clypeal process of the female, which is very distinctive. So far, the males of *C. aequalis aequalis* Provancher have not been distinguished. It is probable they are being confused with the males of *C. nigrescens munda* Mickel.

TYPES.—The type female and allotype male of *C. munda* Mickel, both collected at Sacramento, Calif., by L. Bruner, on Oct. 6, 1916, and Oct. 3, 1916, respectively, are at the University of Nebraska.

The type of *C. abbreviata* Banks, taken at "Yakima City, W. T., July 2, 3, 4, '82," is at the Museum of Comparative Zoology, Harvard, no. 13794.

PREY RECORD.—None.

PLANT RECORD.—CALIFORNIA: *Adenostoma* sp., *Chrysothemnus viscidiflorus typicus*, *Eriogonum fasciculatum*, *E. nudum*, *Helianthus* sp., ladino clover, *Lotus americanus*, *Melilotus alba*, *Phacelia* sp., *Polygonum auberti*, *Salix* sp., *Solidago* sp., *S. californica*, *Trifolium* sp. NEVADA: *Chrysothamnus* sp.

64. *Cerceris nitida* Banks

FIGURES 92, 172a,b,c

Cerceris nitida Banks, 1913b, p. 424, fig. 9.—Mickel, 1917b, p. 454.—Scullen, 1951, p. 1009.

FEMALE.—Length 9 mm. Black with light yellow markings; punctations more limited than average; pubescence very short; slightly more shiny than the average.

Head slightly wider than the thorax; black except the large frontal eye patches, most of the clypeus, evanescent small spot back of the eye, and the base of the mandibles, all of which are very light yellow; clypeal border with five distinct denticles subequally spaced on the medial lobe; clypeal elevation low, acute, depressed, and fuscous; entire clypeal margin and area below the clypeal elevation fuscous; mandibles with three low denticles, the basal one very small; antennae normal in form, fuscous over the scape, peduncle, and the upper surface of the flagellum, the latter light below.

Thorax black except for a divided band on the pronotum, evanescent spots on the scutellum, the metanotum, and a patch on the tegulae, all of which are light yellow; tegulae low and smooth; enclosure with a medial groove, the surface relatively smooth and with pits along the lateral margins; mesosternal tubercle very small; legs black to near the apical ends of the femora, except the hindtrochanter, which is light yellow; apical end of the fore- and midfemora are yellow; apical ends of the hindfemora are ferruginous and the more apical segments of all legs are largely yellow with darker patches; wings subhyaline with the apical region clouded.

Abdomen with a semidivided small patch on tergum 1 and with subequal emarginate bands on terga 2 to 5; venter with light yellow lateral patches on sternite 3 and small evanescent spots on sternite 4; pygidium elongate oval with the apical end rounded and the basal end narrow.

MALE.—Length 8 mm. Black with light yellow markings; punctation very limited; pubescence very short; body shiny.

Head slightly wider than the thorax, black except the entire face,

base of the mandibles, and patch on the scape, all of which are light yellow; clypeal margin with a tridentate medial extension; mandibles without denticles; clypeal surface convex; hair lobes less "waxed" than average and extending over about one-half of the lateral lobe border, blending in with a band of long bristles extending over the lower border of the entire clypeus; antennae normal in form.

Thorax black except for a divided band on the pronotum, the metanotum, and the tegulae, all of which are light yellow; tegulae low and smooth; enclosure smooth except for a light medial groove; mesosternal tubercle absent; legs with the forecoxae black, the other coxae mostly light yellow, all trochanters light yellow, femora black except the apical ends, which are light yellow on the fore- and midlegs and ferruginous on the hindlegs; the tibiae and tarsi largely yellow with some dark patches on those of the hindlegs; wings subhyaline but clouded on the apical area.

Abdomen with narrow light yellow bands on terga 2 to 6, that on tergum 2 somewhat wider than the others, all emarginate; venter with an emarginate band on sternite 3 and small evanescent lateral yellow spots on sternite 4; pygidium with sides subparallel, the ends subequal in width and the apical end rounded.

The female of *C. nitida* Banks is very close to the female of *C. melanthe* Banks. They may be separated by the form and arrangement of the clypeal denticles and by the color of the hindfemora, which are uniformly fuliginous to the apical end on *C. melanthe* Banks but ferruginous on the apical end of *C. nitida* Banks.

TYPES.—The type female of *C. nitida* Banks, from North Carolina, is at the American Museum of Natural History, no. 21185. A male labeled "Type" is at the Museum of Comparative Zoology, Harvard. As this was probably labeled by Banks, it may be considered the allotype.

DISTRIBUTION.—This rare species has been taken in very limited numbers over a wide area from Quebec south to North Carolina, west to Illinois, and southwest to Texas. Specimens are as follows:

ILLINOIS: ♀, Makanda, June 4, 1919. MICHIGAN: ♀, Otonagon Co., June 28, 1955 (R. R. Dreisbach). NEW YORK: ♀, Beaver Creek, McLean "Res." [sic], Sept. 1, 1925. NORTH CAROLINA: ♀, Black Mountains, July 9, 1912 (Beutenmuller); ♀, Valley of Black Mts., June 1906 (W. Beutenmuller). OHIO: 7 ♀ ♀, Put-in-Bay, July 1, 1910 (C. H. Kennedy); 2 ♂ ♂, Put-in-Bay, July 10 (C. H. Kennedy); ♂, Put-in-Bay (C. H. Kennedy). QUEBEC, CANADA: ♀, St. Hilaire, Aug. 28, 1927 (J. W. Buckle). TENNESSEE: ♀, Chimneys C. Gr. [sic], Great Smoky Mountains National Park, 2800 ft., June 12, 1954 (H. E. and M. A. Evans). TEXAS: ♀, Stonewalle, April 16, 1953 (L. D. Beamer); 3 ♀ ♀ [no data].

PREY RECORD.—None.

PLANT RECORD.—None.

65. *Cerceris occipitomaculata* Packard

FIGURES 93, 173a,b,c

Cerceris occipitomaculata Packard, 1866, p. 62.—Cresson, 1872, p. 229; 1887, p. 282.—Schletterer, 1887, p. 498.—Dalla Torre, 1897, p. 469.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Smith, H. S., 1908, p. 368.—Stevens, 1917, p. 422.—Mickel, 1917b, p. 449.—Carter, 1925, p. 133.—Scullen, 1951, p. 1009.

Cerceris fasciola Cresson, 1872, p. 230; 1887, p. 282.—Schletterer, 1887, p. 491.—Ashmead, 1899, p. 295.—Viereck, 1906b, p. 234.—Banks, 1912a, p. 23.—Viereck, 1916, pp. 695–696.—Washburn, 1918, p. 226, fig. 115.—Britton, 1920, p. 342.—Scullen, 1951, p. 1007 (new synonymy).

Cerceris novomexicana Viereck and Cockerell, 1904, p. 137.—Scullen, 1951, p. 1009 (new synonymy).

FEMALE.—Length 11 mm. Black with creamy-yellow markings; punctation somewhat smaller and more scattered than average; pubescence average.

Head slightly wider than the thorax; black except for large frontal eye patches, the clypeal process, the lateral wings of the clypeus, patch above the clypeal process, patch back of the compound eyes, the base of the mandibles, and the scape, all of which are creamy yellow; clypeal border with a prominent extension on the medial lobe with denticle-like processes at the lateral angles; clypeal process subequal in width to the length, relatively flat above, and with the free margin slightly emarginate; mandibles with three denticles closely fused at the base, the medial one much the larger; antennae normal in form, scape creamy yellow, peduncle and flagellum fulvous.

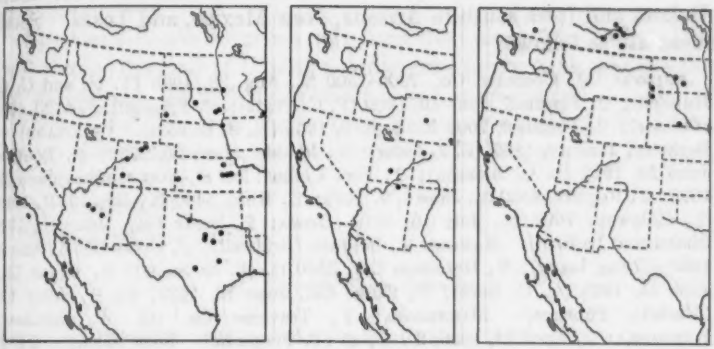
Thorax black except for two patches on the pronotum, the metanotum, large patches on the propodeum, and the tegulae, all of which are creamy yellow; tegulae smooth; enclosure smooth except for a medial groove and very limited punctation in the lateral angles; mesosternal tubercles absent; first two pairs of legs are dark on the basal segments to one-third of the femora, largely yellow beyond to the apical segments of the tarsi, which are fulvous; the hindlegs are dark at the base to and including the basal end of the femora, beyond which they are largely yellow except the apical ends of the femora, which are dark; wings are subhyaline but slightly darker at the apex.

Abdomen with creamy-yellow subequal bands on terga 1 to 5, that on tergum 1 divided; venter immaculate; pygidium with sides converging to an apical rounded point.

MALE.—Length 10 mm. Black with creamy-yellow markings; punctation and pubescence as in female.

Head subequal in width to the thorax; black except for the entire face, small spots back of the compound eyes, base of the mandibles, and the scape, all of which are creamy yellow; clypeal margin slightly extended from the medial lobe, showing two lateral, low, rounded denticles, the usual medial one not evident; the surface of the medial

lobe of the clypeus with a prominent convexity; mandibles with two more or less fused denticles, the more basic one with a divided point and tapering off as a low ridge toward the base of the mandible; antennae with the terminal segment slightly curved; scape yellow and the remaining segments fulvous.



FIGURES 93–95.—Localities of: 93, *C. occipitomaculata* Packard; 94, *C. sexta* Say; 95, *C. nigrosalis* Banks.

Thorax black except for two separated patches on the pronotum, the metanotum, and the tegulae, all of which are creamy yellow; tegulae low and smooth; enclosure faintly ridged about 30° from meson and with a faint medial groove; mesosternal tubercles absent; legs with all coxae black, forelegs black to near the center of the femora, beyond which they are largely yellow, the midlegs yellow except for a dark patch on the femora, the hindlegs yellow on the trochanter and beyond except the apical half of the femora, a patch on the apical end of the tibiae, and the four apical tarsal segments, which are dark; wings subhyaline but slightly darker at the apex.

Abdomen with subequal bands on terga 1 to 6, somewhat emarginate and that on tergum 1 divided; venter dark except for lateral patches on sternites 2, 3, and 4; pygidium with sides subparallel but with the apical end slightly wider than the basal end.

C. occipitomaculata Packard is close to *C. nigrescens* F. Smith. The females can be separated by the form of the clypeal processes. The prominent convex surface of the medial lobe of the clypeus on *C. occipitomaculata* Packard will distinguish the male of that species.

TYPES.—The type female of *C. occipitomaculata* Packard, from Kansas (Norton), has not been located. Recognition of this species is based on specimens so labeled by E. T. Cresson and other earlier workers. A neotype, from Hunt Co., Texas, is being designated by the present writer and is to be deposited at the U.S. National Museum.

The type male of *C. fasciola* Cresson, taken in Comal Co., Texas, is at the Philadelphia Academy of Natural Sciences, no. 1950. The type female of *C. novomexicana* Viereck and Cockerell, from Jackson Park, N. Mex., at skunk cabbage, July 7, 1903 (Anna Gohrman), is at the Philadelphia Academy of Natural Sciences, no. 10383.

DISTRIBUTION.—Central and South Central States, from South Dakota and Iowa south to Arizona, New Mexico, and Texas. Specimens are as follows:

ARIZONA: ♀, Coconino Co., 7200–7500 ft., Aug. 29, 1935 (T. H. and G. G. Hubbell); ♀, Flagstaff, June 10, 1909 (F. C. Pratt); ♂, Flagstaff, Feb. 20, 1933 (Painter); ♀, Flagstaff, 7000 ft., Sept. 5, 1955 (H. A. Scullen). COLORADO: ♀, Berkeley, June 10, 1897 (E. J. Oslar); ♀, Boulder, June 20, 1922; ♂, Boulder, June 20, 1922 (L. O. Jackson); ♀, Fort Collins; 3 ♂♂, Fort Collins, June 22, 1899; ♀, Regnier, 4500 ft., June 6, 9, 1919; ♀, Rifle, 5400 ft., July 19–21, 1919; ♀, Ridgway, 7000 ft., July 10, 1919. IOWA: ♀, Sioux City, June 10, 1949 (Slater and Laffoon). KANSAS: ♀, Baldwin (Bridwell); ♂, Great Bend, June 3, 1952 (Cheng Liang); ♀, Hamilton Co., 3350 ft. (F. H. Snow); ♀, Lyons Co., June 15, 1923 (C. O. Bare); ♀, Osage Co., June 16, 1923; 3 ♀♀, Riley Co. (Marlatt, Popenoe). MINNESOTA: ♀, Traverse Co. (O. W. Oestland). NEBRASKA: ♀, April 24, 1896; 2 ♀♀, ♂ (T. Pergande). NEW MEXICO: 2 ♀♀, Highrolls, May 29–30, 1902. SOUTH DAKOTA: 2 ♂♂, Brookings, June 18, 1921 (H. C. Severin); ♂, Brookings, June 14, 1933 (H. C. Severin); ♂, Hingle, June 15, 1924 (H. C. Severin); ♀, Onida, June 18, 1933 (H. C. Severin); 3 ♂♂, Volga; ♀, Wasta, Pennington Co., June 3, 1941 (G. R. and A. M. Ferguson). TEXAS: 2 ♀♀, Austin, April 22, 1900; 2 ♀♀, Austin, May 9, 1900; ♀, Austin, April 9, 1909 (R. A. Cushman); ♀, Childress, June 8, 1906 (J. D. Mitchell); 3 ♀♀, Dallas, May 9, 1906 (F. C. Bishopp); ♀, Dallas, May 9, 1906 (W. D. Pierce); ♀, Dallas, April 24, 1908; ♀, Denton, May 19 (F. C. Bishopp); ♀, Fedor, April 25, 1896; 2 ♂♂, Fedor, April 2 and 6, 1898 (Birkmann); ♂, Fedor, April 21, 1904 (Birkmann); 2 ♀♀, Fedor, May 11–12, 1905; ♀, Hunt Co., May 17, 1934; 5 ♀♀, 3 ♂♂, Fedor, April 25, 1938 (RWS); ♀, 3 ♂♂, Fedor, May 2, 1939; ♂, Fedor, May 4, 1939; ♀, ♂, Fedor, May 5, 1939; ♂, Fedor, May 9, 1939; ♀, Fedor, May 20, 1939; ♀, Fedor, June 2, 1939; ♀, Fedor, May 6, 1940; ♀, ♂, Fedor, May 11, 1940; ♀, Fedor, May 14, 1940; 2 ♀♀, Roanoke, Denton Co., May 31, 1951 (H. E. Evans); ♀, Wolf Canyon, May 20, 1907 (F. C. Bishopp).

PREY RECORD.—None.

PLANT RECORD.—*Amorpha fruticosa* (Texas), *Eriogonum umbellatum* (Colorado), *Helianthus petiolaris* (Kansas), *Heraculeum lanatum* (Colorado), iris (Arizona), *Pastinaca sativa* (Texas), *Polytaenia nuttallii* (Texas).

66. *Cerceris posticata* Banks

Cerceris posticata Banks, 1916, p. 64; 1947, p. 20.—Scullen, 1951, p. 1010.

FEMALE.—Unknown.

MALE.—Length 15 mm. Black with yellow and light fulvous markings; close to male of *C. sexta* Say in structural details and color pattern except as indicated below.

Head without yellow spot back of the eye; surface of medial clypeal lobe more convex on *posticata*.

Thorax very close to that of *sexta* Say except that patch on the propodeum is smaller than on the latter species.

Abdomen with band on tergum 2 very slightly wider and bands on terga 3 to 6 narrower than on *sexta* Say; bands on sternites more limited than on *sexta* Say.

C. posticata Banks is known only from the unique type male. It is very close to the male of *C. sexta* Say and may prove to be that species. For the present, the writer will retain it as a valid species.

TYPE.—The holotype male, from Jemez Mountains, N. Mex., July 11 (Woodgate), is at the Museum of Comparative Zoology, Harvard, no. 13771.

PREY RECORD.—None.

PLANT RECORD.—None.

67. *Cerceris rhois* Rohwer

Cerceris rhois Rohwer, 1908, p. 325.—Scullen, 1951, p. 1010.

FEMALE.—Unknown.

MALE.—Length 12 mm. Black with yellow and light fulvous markings; close to male of *C. sexta* Say in structural details and color pattern except as indicated below.

Head with the medial clypeal denticle somewhat smaller than the two lateral denticles.

Thorax lacks the yellow patches on the propodeum of *C. sexta* Say.

Abdomen with band on tergum 1 not emarginate and other abdominal bands narrower than on *sexta*.

C. rhois Rohwer is known only from the unique type male. It, like *C. posticata* Banks, is very close to the male of *C. sexta* Say and may prove to be the same species. This also the writer prefers to retain as a valid species until better characters are found for separating closely related males.

TYPE.—The holotype male, from Rio Ruidoso, White Mts., New Mexico, about 6500 ft., July 21, on flowers of *Rhus glabra* (C. T. H. Townsend), is at the U.S. National Museum, no. 28482.

PREY RECORD.—None.

PLANT RECORD.—None.

68. *Cerceris serripes* (Fabricius)

Vespa serripes Fabricius, 1781, p. 464.

Cerceris serripes, Bequaert (not Fabricius) 1928, p. 62 (misassociation for *C. bicornuta* Guérin).—Scullen, 1942, pp. 188, 189.—Strandtmann, 1945, p. 311.—Van der Vecht, 1961, p. 67.

FEMALE.—Length 13 to 15 mm. Black with yellow markings; punctation coarse, but not as close as on *C. halone* Banks, which it most nearly resembles.[14]

Head lost from the type.

Thorax with two patches on the pronotum, line on the scutellum, and large patches on the propodeum, all of which are yellow; enclosure deeply ridged; propodeum very coarsely sculptured.

Abdomen with two lateral patches on tergum 1 separated by a wedge-shaped emargination; tergum 2 with a broad but deeply emarginate band, emargination deep and rounded; terga 3 and 4 with narrower bands, emarginate; tergum 5 with a broad band, slightly emarginate, emargination acute; apical sternite very deeply incised; pygidium with sides converging slightly to a truncate apical end.

The headless, unique type of *Vespa serripes* Fabricius in the British Museum has resulted in considerable confusion since Bequaert published his note on it in 1928. This type has proven to be a misassociation based on a statement by R. E. Turner. On the basis of Bequaert's published note, the writer published his 1942 paper and, from 1942 to 1946, used the name *Cerceris serripes* (Fabricius) when determining specimens of what formerly was and now is known as *C. bicornuta* Guérin. In 1946, specimens of *C. bicornuta* Guérin were sent to Dr. Benson of the British Museum to be compared with the type of *Vespa serripes* Fabricius. On June 20, 1946, Dr. Benson reported that the type of *V. serripes* Fabricius is a female and not a male as reported by Bequaert and, furthermore, that *C. bicornuta* Guérin was "not even closely related to *V. serripes*." Since that date the writer has reverted to using the name *C. bicornuta* Guérin. More recently, several specimens representing species known to be near *C. serripes* (Fabricius) have been compared carefully with that type by Dr. Yarrow. As yet, none have been found that fully agree. *C. halone* Banks appears to be the nearest. For the present, it seems necessary to let *C. serripes* (Fabricius) remain a valid species until there is an opportunity for some specialist to make a more exhaustive study of the problem.

MALE.—Unknown.

TYPE.—The holotype female of *Vespa serripes* Fabricius is in the Banks collection at the British Museum. It bears the label "N.

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[14] This fragmental description is based on private correspondence with Drs. Robert B. Benson and I. H. H. Yarrow of the British Museum and Dr. J. Van der Vecht of Reijksmuseum van Natuurlijke Historie, Leiden, Netherlands (via Dr. Krombein). Sketches furnished by Dr. Benson and Dr. Van der Vecht have been of material help.

Amer" and "63/45," the latter of which Benson indicated is an abbreviation for the British Museum Register No. 1963-45.

PREY RECORD.—None.

PLANT RECORD.—None.

69. *Cerceris sexta* Say

FIGURES 94, 174a,b,c

Cerceris sexta Say, 1837, p. 382.—Smith, F. 1855, p. 465.—LeConte, 1883, p. 763.—Cresson, 1865, p. 119.—Packard, 1866, p. 61.—Patton, 1879, p. 361.—Cresson, 1875, p. 382; 1887, p. 282.—Schletterer, 1887, p. 502.—Ashmead, 1890, p. 32.—Dalla Torre, 1897, p. 476.—Bridwell, 1898, p. 209.—Ashmead, 1899, p. 295.—Viereck, 1906b, p. 234.—Smith, H. S., 1908, p. 365.—Banks, 1913b, p. 424.—Mickel, 1917b, p. 450.—Banks, 1947, p. 10.—Scullen, 1951, p. 1010; 1960, p. 79; 1961, p. 47.

Cerceris biungulata Cresson, 1865, p. 118.—Packard, 1866, p. 61.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 487.—Ashmead, 1890, p. 32.—Dalla Torre, 1897, p. 454.—Ashmead, 1899, p. 295.—Viereck, 1906b, p. 234.—Scullen, 1951, p. 1005; 1960, p. 79.

Cerceris orphne Banks, 1947, pp. 15-16.—Scullen, 1951, p. 1009 (new synonymy).

FEMALE.—Length 15 mm. Black with yellow markings lightly bordered with amber; punctation and pubescence average.

Head subequal in width to the thorax; face largely yellow, large yellow areas on genae, dark amber band on the vertex back of ocelli, clypeal border with a broad medial extension bordered laterally by a corina ending in a denticle, and between these two denticles a placoid-like membrane; clypeal process lunar shaped with the horns very long, curved, and acute; mandibles with three small denticles medially located, the more apical one widely separated from the medial one; antennae normal in form; scape yellow and the flagellum ferruginous, becoming slightly darker apically.

Thorax black except for a deep emarginate band on the pronotum, the scutellum, the metanotum, large areas on the propodeum, patch on the pleuron, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure black, heavily ridged longitudinally; mesosternal tubercles absent; legs amber; wings subhyaline.

Abdomen with tergum 1 largely yellow; terga 2 to 5 with broad yellow bands deeply emarginate with fuscous, the band becoming somewhat broader on tergum 2; venter dark amber to fuscous, becoming lighter on sternite 2; pygidium with sides converging slightly to a truncate apical end.

MALE.—Length 15 mm. Black with yellow markings; punctation and pubescence average.

Head subequal to thorax in width; face yellow; small yellow spots back of eye bordered with fuscous; clypeal border extension showing two lateral low denticles with a barely evident elevation mesad of

the above denticles; a slight medial depression extending from the clypeal margin about two-thirds of the way to the epistomal suture; mandibles somewhat sinuate but without distinct denticles; antennal scape slightly inflated with a yellow patch in front, flagellum dark fuscous with the terminal segment strongly bent.

Thorax black except for two patches on the pronotum, the metanotum, two small patches on the propodeum, and the tegulae, all of which are yellow; enclosure ridged parallel to the meson; mesosternal tubercles absent; legs light ferruginous with large yellow areas on most segments beyond the trochanter; wings subhyaline.

Abdomen black and yellow; tergum 1 with large lateral yellow patches; terga 2 to 6 with subequal broad yellow bands emarginate with black anteriorly; venter dark fuscous with lateral yellow patches on sternites 2, 3, and 4. Both sexes may show more or less dark ferruginous or fuscous areas on the vertex, the genae of the head, and the scutellum of the thorax.

TYPES.—Say's original male type has been lost. A neotype male, from Colorado, designated by the present writer, is deposited at the Philadelphia Academy of Natural Sciences, no. 5041. The type female of *C. biungulata* Cresson, from the Rocky Mts., Colorado (Riding), is at the Philadelphia Academy of Natural Sciences, no. 1956. The type male of *C. orphne* Banks, from Jemez Springs, N. Mex., July 2 (Englehardt), is at the Museum of Comparative Zoology, Harvard, no. 23536.

DISTRIBUTION.—Through the South Central States, from Nebraska and Colorado south to Arizona. Specimens are as follows:

ARIZONA: ♀, at base of Humphrey's Peak, 9500 ft., August (Snow); ♀, Navajo Mts., Navajo Co., July 13, 1933 (Stanley Bee); ♀, Rainbow Lodge, Navajo Mts., Coconino Co., 6500 ft., July 15, 1933 (Stanley Bee); ♀, Oak Creek Canyon, 6000 ft., (F. H. Snow); 2 ♀ ♀, Rainbow Lodge. COLORADO: ♀, Berkley, June 3; ♀, "Colorado" (C. F. Baker); ♀, Meeker, 6200 ft., July 20–21, 1919; ♀, Pleasant Valley, Aug. 19, 1906. KANSAS: 2 ♂ ♂, Greeley Co. NEW MEXICO: ♀, Koehler (W. R. Walton). UTAH: ♀, Boulder, Sept. 11, 1949 (C. J. Stewart). WYOMING: ♀, Cheyenne, Aug. 23, 1931; ♀, Lander, July 22, 1953 (R. R. Dreisbach).

PREY RECORDS.—None.

PLANT RECORD.—None.

70. *Cerceris stigmosalis* Banks

FIGURES 95, 175a,b,c

Cerceris stigmosalis Banks, 1916, p. 64.—Stevens, 1917, p. 422.—Scullen, 1951, p. 1010; 1960, p. 79.

Cerceris fugatrix Mickel, 1917a, pp. 335, 336; 1917b, p. 452.—Scullen, 1951, p. 1008.

Cerceris sayi Banks, 1923, p. 21.—Scullen, 1951, p. 1008.

Cerceris stevensi Banks, 1923, p. 22.—Scullen, 1951, p. 1008.

FEMALE.—Length 15 to 18 mm. Black with pale yellow to creamy-white markings; punctation average; pubescence slightly longer than average.

Head subequal in width to the thorax; black except for large eye patches on the face, surface of the clypeal process, base of mandibles, and large round spots back of the compound eyes, all of which are pale yellow; clypeal border with a medial extension bordered laterally by an irregular heavy carina; clypeal process broader than long with the points somewhat angular; mandibles black except at the base with two adjoining small subequal denticles; antennae normal in form, basal half light amber, and apical half somewhat darker.

Thorax black except two elongate patches on the pronotum, the scutellum, and large patches on the propodeum, all of which are pale yellow; tegulae amber, low, and smooth; enclosure ridged longitudinally but spreading out somewhat posteriorly; mesosternal tubercles absent; legs reddish amber with the basal segments darker; wings subhyaline tinged with amber.

Abdomen black with pale yellow to creamy-white markings; tergum 1 with two large light yellow patches; terga 2 to 5 with broad but deeply emarginate light yellow bands; tergum 6 black; venter black; pygidium with sides converging apically to a truncate end.

MALE.—Length 14 to 15 mm. The type, which is a small specimen, is 12 mm. Black with pale yellow or creamy-white markings; punctation average; pubescence slightly longer than average.

Head black except entire face, small round spot back of eyes, base of mandibles, and scape, all of which are pale yellow; clypeal border with medial lobe extended and with three small denticles on the margin of the extension; hair lobes on the lateral wings only; mandibles with a broad lobe medially on the lower margin; antennae dark amber with the basal segments lighter and the scape yellow, terminal segment curved.

Thorax black with two large patches on the pronotum, the scutellum, patch on the propodeum, and the tegulae, all of which are pale yellow; tegulae low and smooth; enclosure with a medial groove, smooth except for lateral ridges approximately 45° to the base; mesosternal tubercles absent; fore- and midlegs dark fuscous to near the center of the femora, beyond which they are yellow; the hindlegs are mostly yellow basally to beyond the center of the femora, which are light amber on the apical third; apical segments of the hindlegs are yellow infused with amber; wings subhyaline tinged with amber.

Abdomen black with two pale yellow patches on tergum 1; terga 2 to 6 with broad pale yellow bands deeply emarginate; tergum 7 black; venter black except for lateral pale yellow patches on sternites 2 to 5; pygidium with sides subparallel and apical corners rounded.

The principal variations are found in the clypeal process of the female, which may have the points considerably extended and the yellow markings on the surface greatly reduced or completely absent. *Cerceris stigmosalis* Banks most closely resembles *Cerceris sexta* Say, from which the females of the former may be separated by the form of their processes and the much lighter shade of their markings. Possibly *stigmosalis* should be considered a subspecies of the latter.

TYPES.—The type male of *C. stigmosalis* Banks, from Fargo, N. Dak., September, on *Solidago* sp. (Stevens), is at the Museum of Comparative Zoology, Harvard, no. 13778. The type male of *C. fugatrix* Mickel, from Mitchell, Nebr., Aug. 4, 1916 (C. E. Mickel), is at the University of Nebraska. The type female and allotype male of *C. sayi* Banks, from Steele, N. Dak., July 13 (Stevens), are at the Museum of Comparative Zoology, Harvard, no. 14706. The type female of *C. stevensi* Banks, from Steele, N. Dak., (Stevens), is at the Museum of Comparative Zoology, Harvard, no. 14707.

DISTRIBUTION.—In the United States and Canada *stigmosalis* is found in the North Central States, from Alberta south to Nebraska. The same species has been taken on the plateaus of central Mexico by the writer and other workers. Specimens are as follows:

ALBERTA: ♂, Bow Island, July 14, 1937 (C. L. Neilson); ♂, Cypress, July 24, 1923 (E. H. Strickland); 2 ♂♂, Lethbridge, July 29, 1916 (Sladen); 3 ♀♀, 2 ♂♂, Lethbridge, July 28, Aug. 8, 14, 1914, Aug. 14, 1922, Aug. 15, 1939 (E. H. Strickland); 3 ♀♀, 5 ♂♂, Lethbridge, July 24, 1922, Aug. 8, 1923, July 2, 5, 6, 8, 1923 (H. E. Gray); ♂, Lethbridge, Aug. 7, 1923 (Walter Carter); ♀, 2 ♂♂, Lethbridge, Aug. 9, 1926 (E. R. Tinkham); 2 ♀♀, 5 ♂♂, Lethbridge, Aug. 20, 1921, July 27, 29, 1922 (H. L. Seamans); ♀, Lethbridge, July 1, 1940 (R. W. Salt); 4 ♀♀, 8 ♂♂, Manyberries, Aug. 11, 1939 (E. H. Strickland); ♂, Manyberries, July 14, 1949 (Gordon A. Hobbs); 10 ♀♀, 4 ♂♂, Medicine Hat, Aug. 7, 1938, July 29, 1939, Aug. 9, 1939, Aug. 11, 1941 (E. H. Strickland); 3 ♀♀, Medicine Hat, Aug. 1, 1917, July 23, Aug. 23, 1919 (Sladen); ♀, Medicine Hat (J. R. Mallock); ♀, Medicine Hat, Aug. 16, 1939 (J. L. Carr); ♂, Pple. Spgs. [sic], July 1922 (H. L. Seamans); 3 ♂♂, Suffield, July 29, 1949 (Gordon A. Hobbs); 5 ♀♀, 7 ♂♂, Tilley, Aug. 23, 1939, July 12, Aug. 11, 15, 1940, July 9, 20, 1941 (J. L. Carr). BRITISH COLUMBIA: ♀, Summerland, Aug. 10, 1916 (Sladen). MONTANA: ♂, Elkhorn Mts. (W. M. Mann); ♀, Laurel, July 12, 1914 (M. A. C.); NORTH DAKOTA: ♂, Marmantle, July 30, 1934 (A. C. Fox); 10 ♀♀, 8 ♂♂, Steele, July 13, 1919, Aug. 18, 1922, Aug. 4, 1923 (O. A. Stevens); ♀, Washburn, July 23, 1926 (O. A. Stevens). SOUTH DAKOTA: ♂, Buffalo, Sept. 9, 1927 (H. C. Severin); ♀, Wewela, Sept. 16, 1930 (H. C. Severin). MEXICO: 3 ♀♀, 64 mi. NE. Durango, Durango, 6500 ft., Oct. 19, 1957 (H. A. Scullen); 6 ♀♀, 3 ♂♂, San Luis Potosí, S. L. P., 7300 ft., Oct. 1–2, 1957 (H. A. Scullen).

PREY RECORD.—None.

PLANT RECORD.—*Cleome serrulata* (Alberta), *Kuhnistera oligophylla* (North Dakota), *Solidago* sp. (North Dakota).

71. *Cerceris tepaneca* Saussure

FIGURES 96, 176a,b,c

Cerceris tepaneca Saussure, 1867, p. 90.—Schletterer, 1887, p. 504.—Cameron, 1890, p. 125.—Dalla Torre, 1897, p. 478.—Ashmead, 1899, p. 296.—Scullen, 1961, p. 48.

Cerceris sextoides Banks, 1947, p. 10.—Scullen, 1951, p. 1010.

Cerceris eurymele Banks, 1947, pp. 11–12.

FEMALE.—Length 15 mm. Black with yellow markings; punctation and pubescence average.

Head slightly wider than the thorax; face, base of mandibles, scape, and large patch back of the eyes, all yellow; clypeal border black with five denticles, the two lateral ones and the medial one smaller than the other two; clypeal process with spreading blunt points deeply concave between them, dark at the tips, mandibles with three separated denticles, the more apical one much the largest; antennae normal in form, scape yellow, flagellum ferruginous basally, becoming dark apically.

Thorax black except for two emarginate patches on the pronotum, the metanotum, large patches on the propodeum, and the tegulae, all of which are yellow; tegulae low and smooth; enclosure deeply ridged longitudinally; mesosternal tubercle absent; legs black on basal parts, including the basal end of the femora, beyond which they are yellow infused with amber and becoming more ferruginous on the apical parts; wings subhyaline tinged with amber.

Abdomen black and yellow; first tergum with two separated yellow patches; terga 2 to 5 largely yellow with variable amounts of black in the center of each; tergum 6 with yellow to the sides of the pygidium; venter with broad emarginate bands of yellow on sternites 2, 3, 4, and 5; pygidium with sides slightly converging to a smaller apical end.

MALE.—Length 13 mm. Black with yellow markings; punctation and pubescence average.

Head subequal in width to the thorax; black except the entire face, base of mandibles, the scape, and a small spot back of the eye, all of which are yellow; clypeal border extended with three low denticles on the margin; hair lobes extending about half way to the meson; clypeal surface convex; mandibles with three very low denticle-like elevations; antennae with the terminal segment slightly curved.

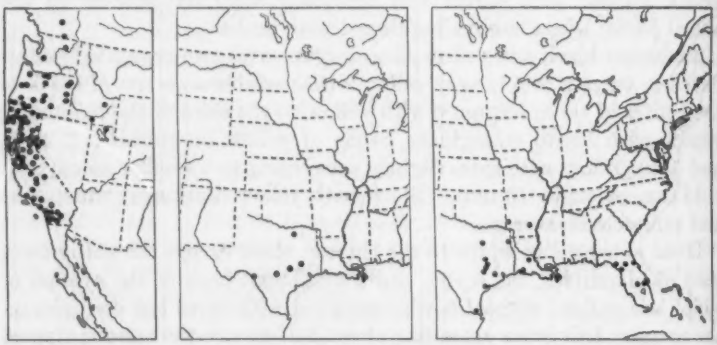
Thorax black except for two elongate patches on the pronotum, the metanotum, and the tegulae, all of which are yellow; tegulae low and smooth; mesosternal tubercle absent; enclosure deeply ridged longitudinally but spreading posteriorly; legs yellow except the forelegs, which are fuscous basally to the center of the femora; midlegs with a fuscous patch near the basal end of the femora; hindlegs with the apical ends of the femora fuscous and a fuscous patch on the apical end of the tibiae; wings subhyaline lightly tinged with amber.

Abdomen black except the first tergum, which has two large lateral yellow patches; terga 2 to 5 are mostly yellow with black emarginations basally; tergum 6 mostly yellow; venter with more or less emarginate yellow bands on sternites 2, 3, 4, and 5 and small lateral yellow spots on sternite 6; pygidium with sides subparallel.

The extension of the yellow markings varies. This is especially true of the terga. *C. eurymele* Banks represents the extreme yellow form. The shape of the clypeal process on the female is quite variable. A series of specimens collected by F. X. Williams on the sand hills of San Francisco show noticeably longer pubescence. In recent years, colonies on these sand hills have been eliminated by expanding residential districts.

TYPES.—A male specimen of Saussure's original type series of *C. tepaneca* at Vienna, described from Orizaba, Mexico, has been designated a lectotype by the present writer. The type female of *C. sextoides* Banks, from Lone Tree, Yakima River, Wash., June 30, 1882 (S. Henshaw), and the type female of *C. eurymele* Banks, from Davis, Calif., June 30 (Bohart), are at the Museum of Comparative Zoology, Harvard, nos. 23547 and 23546, respectively.

DISTRIBUTION.—Throughout the Pacific Slope States, from British Columbia south and into Mexico.



FIGURES 96–98.—Localities of: 96, *C. tepaneca* Saussure; 97, *C. texana* Scullen; 98, *C. toltica* Saussure.

PREY RECORD.—*Sitona californicus* Fabricius (Antioch, Calif.). *Trigonoscuta pilosa* Mots (San Francisco sand dunes, Calif.).

PLANT RECORD.—*Baccharis Emoryi* (California), *Chrysothamnus nauseosus consimilis* (California), *C. viscidiflorus* (California), *Croton californicus* (California), *Daucus carota* (Oregon), *Eremocarpus sati-*

gerus (California), *Eriogonum* sp. (California), *E. fasciculatum* (California), *Foeniculum vulgare* (California), *Gutierrezia sarothrae* (California), *Melilotus alba* (California, Oregon), *Polygonum auberti* (California), privet (California), *Rosa* sp. (California), *Solidago* sp. (California), *S. occidentalis* (California).

72. *Cerceris texana*, new species

Figures 97, 177a,b,c

Female.—Length 11 mm. Black with lemon-yellow markings; punctation small; pubescence average.

Head subequal in width to the thorax; black except for large frontal eye patches, dorsal surface of the process, spot back of the eye, base of the mandibles, and a small patch on the scape, all of which are yellow; clypeal border with a broad extension on the medial lobe; clypeal process slightly broader than long, with a denticle-like extension on the lateral angles of the free terminal border; mandibles with one large denticle, basad of which is a small one; antennae normal in form.

Thorax black except for two widely separated patches on the pronotum, the metanotum, and a patch on the tegulae, all of which are yellow; tegulae low and smooth; enclosure finely ridged at a slight angle to the medial groove; mesosternal tubercle absent; legs fulvous with the two basal segments darker; wings subhyaline, clouded at the apical margin.

Abdomen with subequal medium-width bands emarginate on all terga 1 to 5, the first one being divided; venter immaculate; pygidium wedge shaped, with the apical end small and rounded.

Male.—Unknown.

The female of *C. texana* Scullen is very close to the female of *C. clypeata clypeata* Dahlbom but the former may be distinguished from the latter species by the form of the clypeal process. The female also resembles the female of *C. aequalis aequalis* Provancher in general form and color but the clypeal processes are quite different.

Types.—The type female of *C. texana* Scullen, from Del Rio, Tex., Apr. 13, 1949 (Michener-Beamer), is at the University of Kansas, no. 6068. Paratypes are as follows:

Texas: ♀, Brazos Co., June 3, 1939 (J. E. Gillaspy); 3 ♀♀, Fedor, 1897 (Birkmann); ♀, Fedor, June, 1898 (Birkmann); 3 ♀♀, Fedor; ♀, Ft. Sam Houston, Bexar Co., Mar. 22, 1953 (M. Wasbauer); ♀, Omas Park, Bexar Co., Mar. 23, 1953 (M. Wasbauer); ♀ [no data].

Distribution.—Known only from Texas.

Prey record.—None.

Plant record.—None.

73. *Cerceris tolteca* Saussure

FIGURES 98, 178a,b,c

Cerceris tolteca Saussure, 1867, p. 94.—Schletterer, 1887, p. 504.—Cameron, 1890, p. 109.—Dalla Torre, 1897, p. 478.—Ashmead, 1899, p. 296.—Scullen, 1961, p. 48.

Cerceris cosmiocephala Cameron, 1904, p. 67.

FEMALE.—Length 11 mm. Black to dark amber with yellow and light amber markings; punctation light and not crowded; pubescence average.

Head subequal in width to the thorax; black except most of face below antennal scrobes, line between the antennae, two elongate patches on the vertex, patch back of the eye, basal half of mandibles, and scape, all of which are yellow; clypeal margin with two prominent and irregular elevations opposite the lateral angles of the clypeal process; between these two elevations a deep recess continuous with the depression of the clypeal process; a prominent row of bristles between the above marginal elevations, and the lateral angles of the clypeal process extending to the bases of the mandibles; the clypeal process closely resembling that of *C. bicornuta* Guérin in miniature form but the dorsal surface of the process not lunar in *C. tolteca* Saussure as in *C. bicornuta* Guérin; mandibles with a thin corina extending from near the base of the mandibles to an abrupt denticle-like ending near the center of the mandible; apical end and denticle-like process of the mandible dark amber; antennae normal in form.

Thorax black except band on prothorax, semidivided band on the scutellum and the metanotum, small elongate patches on the propodeum and the tegulae, all of which are yellow somewhat tinged with amber; tegulae low and smooth; enclosure smooth and shiny except for a faint medial groove and pits along the lateral margins; mesosternal tubercles absent; legs dark amber to black on the coxae and trochanters, light amber becoming yellow on the femora and yellow amber beyond; wings subhyaline with amber shading.

Abdomen with a broad yellow band posteriorly on tergum 1; tergum 2 largely black to dark amber with lateral yellow patches and traces of yellow posteriorly; tergum 3 yellow; terga 4 and 5 with broad yellow bands slightly emarginate with black; tergum 6 mostly yellow, becoming somewhat amber on the pygidium; venter dark amber with small patches of yellow laterally on sternites 3, 4, and 5; pygidium with sides convex and ends subequal in width.

MALE.—Length 9 mm. Black or dark amber with yellow markings; punctation and pubescence average.

Head black except most of face, two elongate patches on the vertex, patches back of the compound eyes, base of the mandibles, and the scape, all of which are yellow; clypeal border with three denticles;

hair lobes very broad extending from the lateral denticles to the eyes, noticeably amber in color; clypeal surface slightly convex; mandibles without denticles; antennae normal in form.

Thorax black except for band on the pronotum, the scutellum, the metanotum, patches on the propodeum, spots on the pleuron, and the tegulae, all of which are yellow; tegulae smooth and very slightly elevated; enclosure smooth and shiny except for a faint medial groove and pits along the lateral margins; mesosternal tubercles absent; legs black basally, becoming yellow in part on the femora and mostly yellow beyond; wings subhyaline clouded with amber.

Abdomen with a yellow band on tergum 1; tergum 2 black or with a narrow yellow band anteriorly; tergum 3 yellow; terga 4, 5, and 6 with yellow bands infused with amber and black; venter black to dark amber with yellow spots appearing on sternites 3 and 4; pygidium semioval with the apical end truncate.

Both sexes show considerable variation in the extent of the yellow markings and the darker background color may be medium amber. The female of *C. tolteca* Saussure is very distinct even when compared with others, which run close to it in the keys. The clypeal process is very different from that of any other species near its size. The general color pattern of the male, the broad amber hair lobes, and the more oval pygidium easily distinguish that sex.

TYPES.—The lectotype female of *tolteca* Saussure, designated by the writer and from near Cuernavaca, Mexico, is at the Museum d'Histoire Naturelle, Vienna. The original type, also from Cuernavaca, Mexico, has not been found.

The holotype male of *C. cosmiocephala* Cameron, from San Marcos, Nicaragua (C. F. Baker), is at the British Museum, no. 21.1,737.

DISTRIBUTION.—Through the Southern States, from Arizona to Florida, north to Oklahoma and Arkansas, and south into Central America. Specimens are as follows:

ARIZONA: ♀, Amado, July 23, 1957 (G. D. Butler); 3♀♀, 2♂♂, Canelo, July 3, 1956 (G. D. Butler); ♂, Nogales, Aug. 3, 1927 (J. C. Bradley); ♂, Patagonia, Santa Cruz Co., Aug. 25, 1955 (F. G. Werner, G. D. Butler); ♂, Portal, Aug. 10, 1959 (H. E. Evans); ♀, Sonoita, Santa Cruz Co., Sept. 6, 1957 (T. R. Haig). ARKANSAS: ♂, Jefferson Co., July 8, 1954 (L. D. Warren); ♀, Lincoln Co., July 2, 1953; ♂, Polk Co., Aug. 21, 1928 (L. D. Beamer). FLORIDA: ♀, Cocoa, July 1 (G. E. Bohart); ♂, Gainesville, July 8, 1955 (R. A. Morse); 2♂♂, Haines City, Sept. 17, 1954 (H. V. Weems, Jr.); ♂, Levy Co., July 19, 1958 (H. V. Weems, Jr.). LOUISIANA: ♀, ♂, Cameron, June 6–14, 1905; ♂, Keatchie, June 14, 1905; 2♂♂, Opelousas (G. P. Pilate); 2♂♂, Orange, Aug. 23, 1907 (F. C. Bishopp); ♂, Winnfield, July 21. OKLAHOMA: ♂, Great Salt Plains, Alfalfa Co., July 24, 1953 (Evans and others). TEXAS: ♂, Brownsville, June 25, 1930 (J. O. Martin); ♂, Brazos Co., June 20, 1937 (J. E. Gillaspy); ♀, 2♂♂, Calvert, June 22, 1904 (F. C. Bishopp); 4♂♂, Fedor, Lee Co., June 17–29, 1909; 2♂♂, Lee Co. (Birkmann); ♂, McDade, Bastrope Co., June 27, 1934 (J. E.

Gillaspy); 3 ♀ ♀, 9 ♂ ♂, Richmond, Fort Bend Co., June 22, 1917 (Bequaert); ♂, Tarrant Co., June 13, 1948 (Barr); ♂, Victoria, June 29, 1903 (A. W. Morrill); ♂, Waskom, Harrison Co., June 18, 1958 (R. L. Fischer); ♀, Wellborn, June 29, 1937 (Strandtmann).

PREY RECORD.—None.

PLANT RECORD.—Alfalfa (Arizona), *Bidens pipennata* (Florida), *Donellsmithia hintonii* (Mexico), *Richardia scabra* (Florida).

74. *Cerceris varians* Mickel

FIGURES 99, 179a,b,c

Cerceris varians Mickel, 1917a, p. 336.—Banks, 1947, p. 18.—Scullen, 1951, p. 1010.

FEMALE.—Length 11 mm. Black with yellow markings; punctation and pubescence average.

Head slightly wider than the thorax; black except for the two large frontal eye patches, upper surface of the clypeal process, lateral wings of the clypeus, mesal patch dorsad of the clypeus, spot back of the eye, base of the mandibles, and patch on the scape, all of which are yellow; clypeal border with an extension from the medial lobe, which has a sinuate margin and a smooth depressed area above the margin; clypeal process with the sides converging apically to an emarginate end subequal in width to the epistomal suture; mandibles with two distinct denticles, the more apical one the larger, and basad of the smaller one a slight elevation where a third denticle would be; antennae normal in form.

Thorax black except for two widely separated small patches on the pronotum, a divided band on the metanotum, large patch on the propodeum, and a patch on the tegulae, all of which are yellow; tegulae low and smooth; enclosure finely ridged with the ridges running at an angle to the base; mesosternal tubercles absent; legs largely yellow except the two basal segments, base of the femora, and the apical ends of the hindfemora, which are black; wings subhyaline.

Abdomen with a broad divided band on tergum 1, broad but deeply emarginate bands on terga 2 to 5; sternum immaculate or with lateral yellow patches on sternites 2, 3, and 4; pygidium with the sides converging to a rounded apical end.

MALE.—Unrecognizable. In the *aequalis* complex.

The female of *C. varians* Mickel closely resembles the female of *C. aequalis aequalis* Provancher in size, structure, and color pattern, from which species the former is separated by the form of its clypeal process. The males are inseparable at present.

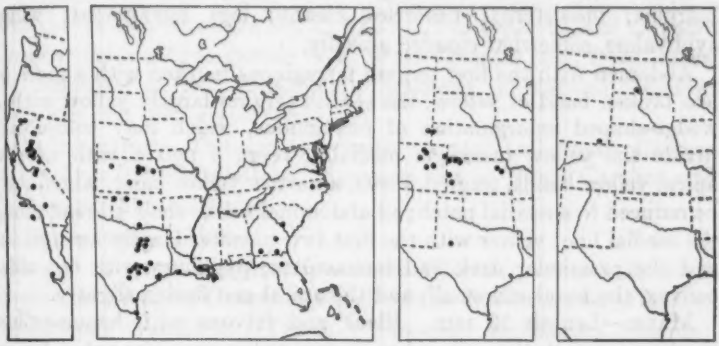
TYPES.—The type female and allotype male of *C. varians* Mickel, from Donner Lake, Placer Co., Calif., taken Aug. 24, 1916 (L. Bruner),

and Aug. 21, 1916 (L. Bruner), respectively, are at the University of Nebraska.

DISTRIBUTION.—*C. varians* Mickel is confined to California with the exception of two specimens labeled "Nev." and one from near Zitácuaro, Michoacán, Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Chrysothamnus* sp., *Solidago* sp. (both records from California).



FIGURES 99–102.—Localities of: 99, *C. varians* Mickel; 100, *C. verticalis* F. Smith; 101, *C. vicina* Cresson; 102, *C. wyomingensis* Scullen.

75. *Cerceris verticalis* F. Smith

FIGURES 100, 180a,b,c

Cerceris verticalis F. Smith, 1856, p. 466.—Cresson, 1865, p. 130.—Packard, 1866, p. 64.—Cresson, 1887, p. 282.—Schletterer, 1887, p. 505.—Dalla Torre, 1897, p. 481.—Ashmead, 1899, p. 296.—Scullen, 1951, p. 1010; 1961, p. 48.

Cerceris gnara Cresson, 1872, p. 229; 1887, p. 282.—Schletterer, 1887, p. 483.—Dalla Torre, 1897, p. 462.—Ashmead, 1899, p. 295.—Banks, 1912a, p. 22.—Mickel, 1917b, p. 449.—Scullen, 1951, p. 1008; 1960, p. 78.

Cerceris firma Cresson, 1872, p. 229; 1887, p. 282.—Schletterer, 1887, p. 491.—Dalla Torre, 1897, p. 460.—Ashmead, 1899, p. 295.—Banks, 1912a, p. 20.—Scullen, 1951, p. 1007; 1960, p. 78.

FEMALE.—Length 16 mm. Black with ferruginous and yellow markings; punctation average; pubescence conspicuous and somewhat longer than average.

Head largely ferruginous except for the large frontal eye patches, patch on the clypeal process, and the base of the mandibles, all of which are yellow, and an area about the antennal scrobes and the clypeal denticles, which are dark; clypeal border with two prominent denticles separated by a deep depression, these denticles each

flanked laterally by a smaller denticle; clypeal process with the free margin converging to an acute point; to each side of the process an indistinct denticle; prominent bristles covering much of the clypeal border; mandibles with two denticles, the more basal one much the larger; antennae normal in form.

Thorax black except for two separated fulvous patches on the pronotum, the metanotum, which is yellow, and large patches on the propodeum, which are ferruginous; tegulae low, smooth, and fuliginous; enclosure with a medial groove and deep pits along the lateral margins; mesosternal tubercles absent; legs ferruginous; wings subhyaline, somewhat clouded apically.

Abdomen with the first tergum ferruginous marked with a more or less broken band of yellow, the second tergum largely yellow with a wedge-shaped emargination of ferruginous, which may completely divide the yellow markings medially; terga 3 and 4 with narrow apical yellow bands, tergum 5 with a narrow yellow band, which may be reduced to a medial patch; all abdominal bands show a break along the medial line; venter with the first two sternites largely ferruginous and the remainder dark and immaculate; pygidium with the sides convex, the basal end small, and the apical end flaring slightly.

MALE.—Length 13 mm. Black and fulvous with lemon-yellow markings; punctation somewhat coarse; pubescence somewhat longer than average.

Head slightly wider than the thorax, black except for the entire face below the antennal scrobes, basal two-thirds of the mandibles, and patch on the scape, all of which are lemon yellow; clypeal border with three denticles on the medial lobe, the medial one being much the longest; clypeal surface slightly convex; hair lobes extending over the lateral clypeal lobes; mandibles with one denticle; antennae with the terminal segment slightly curved and blunt.

Thorax black except for two separated patches on the pronotum, the metanotum, small spots on the propodeum, and spots on the tegulae, all of which are yellow; tegulae low and smooth; enclosure with a medial groove and one or two deep pits in the lateral angles; mesosternal tubercles absent; legs with the coxae very dark, the foretrochanters and forefemora fulvous except for yellow patches on the latter, the mid- and hindtrochanters yellow, the midfemora fulvous except for a yellow patch, the hindfemora yellow on the basal half and fulvous on the apical half, the remaining parts fulvous to fuliginous; wings subhyaline.

Abdomen with the first tergum fuscous with two large lateral patches and two small medial spots of yellow; tergum 2 with a broad band deeply emarginate and divided medially; terga 3 to 6 with narrow posterior bands all divided medially; venter immaculate; pygidium

almost as broad at its base as it is long, sides converging to a slightly narrower apical end.

Both sexes of *C. verticalis* F. Smith superficially resemble those of *C. mimica* Cresson. The females of these species can easily be separated by the quite different clypeal processes. The males are separated by the form of the pygidium, which is much narrower on *C. mimica* Cresson. The latter also has a very distinctive series of lateral clusters of bristles on each sternite.

TYPES.—The type female of *C. verticalis* F. Smith, from Georgia, is at the British Museum, no. 21.1,431. The type male of *C. gnara* Cresson and the type female of *C. firma* Cresson, both from Texas, are deposited at the Philadelphia Academy of Natural Sciences, nos. 1938 and 1945, respectively.

DISTRIBUTION.—Through the South Central and South Eastern States, from Kansas south to Texas and east to North Carolina and Florida, south into Mexico.

PREY RECORD.—None.

PLANT RECORD.—*Ampelopsis arborea* (Florida), cactus (Kansas), *Cirsium* sp. (Texas), *Daucus carota* (Florida), *Melilotus alba* (Florida), *Petalostemon multiflorum* (Texas), *Ptilimnium capillaceum* (Florida), *Polytaenia nuttallii* (Texas).

76. *Cerceris vicina* Cresson

FIGURES 101, 181a,b,c

Cerceris vicina Cresson, 1865, p 120.—Packard, 1866, p. 61.—Cresson, 1887, p 282.—Schletterer, 1887, p. 505.—Ashmead, 1890, p. 32.—Dalla Torre, 1897, p. 481.—Ashmead, 1899, p. 296.—Smith, H S., 1908, p. 367.—Mickel, 1917b, p. 450.—Banks, 1947, p. 20.—Scullen, 1951, 1011.

Cerceris platyrhina Viereck and Cockerell, 1904, p. 133.—Viereck, 1906b, pp. 234, 239.—Scullen, 1942, p. 188 (erroneously synonymized with *morata* Cresson) (new synonymy).

FEMALE.—Length 14 mm. Black with yellow and ferruginous markings; punctation and pubescence average.

Head subequal in width to the thorax; most of face below antennal scrobes yellow bordered with ferruginous, otherwise black except for spots back of compound eyes, base of mandibles, and scape, all of which are yellow bordered by ferruginous; clypeal border with two very broad and rounded extensions on the medial lobe, between which is a deep depression; clypeal process with the sides converging to a narrow truncate apical end, which is slightly emarginate; mandibles with three distinct denticles, the most apical one much the largest; antennae normal in form.

Thorax black except for a yellow band on the pronotum, divided by an area of ferruginous, and the yellow metanotum; tegulae low, smooth, and yellow bordered with ferruginous; enclosure heavily ridged longitudinally; mesosternal tubercles absent; legs ferruginous shading into yellow on some more apical segments; wings subhyaline clouded with ferruginous.

Abdomen with the first tergum largely ferruginous, a broad yellow band on tergum 2 bordered with ferruginous, terga 3 and 4 with narrow bands becoming broad laterally and tergum 5 with a broad but emarginate band; venter dark with somewhat lighter posterior margins; pygidium with sides slightly convex and converging to a round apical end.

MALE.—Indistinguishable.

Three male specimens taken at Scott City, Kans., July 1929 (V. F. Calkins) (the same place, time, and collector as for the three females), agree very well with specimens of males of *C. morata* Cresson. One of the above three males is dark and has all but lost its ferruginous coloring and, as a result, very closely agrees with the males of *C. clypeata* Dahlbom. The southern range of *C. vicina* Cresson so overlaps the northern range of *C. morata* Cresson, that, for the present, the writer is unable to distinguish between the males of these two species within the overlapping area.

C. vicina Cresson shows the usual variation in the extent of the colored markings. It is related most closely to *C. morata* Cresson, from which the females of the former may be separated by the form of their clypeal processes. The latter species is taken largely in Texas, New Mexico, and adjoining states.

TYPES.—The type female of *C. vicina* Cresson, from the Rocky Mts., Colorado Territory (Riding), is at the Philadelphia Academy of Natural Sciences, no. 1939. The type female of *C. platyrhina* Viereck and Cockerell, from Filmore Canyon, Organ Mts., N. Mex., Aug. 29 (Cockerell), is at the Philadelphia Academy of Natural Sciences, no. 10384.

DISTRIBUTION.—On the east slope of the Rocky Mts. in Nebraska, Kansas, and Colorado. Specimens are as follows:

COLORADO: ♀, Boulder, Oct. 14, 1930 (C. A. Smith); 3 ♀♀, "Colo." (C. F. Baker); ♀, Colorado City, Bear Creek Canyon, July (E. S. Tucker); ♀, Colorado Springs, El Paso Co., Aug. 13, 1945 (I. J. Central); 2 ♀♀, Fort Collins, July 11, 1937, July 11, 1938 (M. T. James); ♀, Greeley, Sept. 19, 1931, *Solidago* sp. (R. Sumaer); ♀, Limon, Aug. 16, 1949 (R. R. Dreisbach); 2 ♀♀, Wray, 3700 ft., Aug. 17–19, 1919. KANSAS: ♀, Blackjack Creek, Pottawatomie Co., July 3, 1953 (Evans and party); ♀, Cheyenne Co., 3300 ft. (F. X. Williams); ♀, Douglas Co., 900 ft. (F. X. Williams); ♀, Ellis Co., 2000 ft., July 19, 1912 (F. X. Williams); ♀, Rowlins Co., 2850 ft.; ♀, Rooks Co., 1775 ft., Aug. 9, 1912; 3♀♀, 3 ♂♂, Scott City, July 1929 (V. F. Corkins); ♀, Scott Co.,

Aug. 21, 1952 (H. E. Evans); ♀, Wichita Co., 3300 ft. (F. X. Williams). NEBRASKA: ♀, Mitchell, July 17, 1916 (C. E. Mickel). TEXAS: ♀, Conlen, Aug. 8, 1952 (R. R. Dreisbach). WYOMING: ♀, Terrington, Aug. 1, 1943 (D. G. Denning).

PREY RECORD.—None.

PLANT RECORD.—*Melilotus alba* (Nebraska), *Solidago* sp. (Colorado).

77. *Cerceris wyomingensis*, new species

FIGURES 102, 182a,b,c

FEMALE.—Length 11 to 12 mm. Black with light yellow and ferruginous markings; punctation average; pubescence short.

Head subequal in width to the thorax; black except for large frontal eye patches, most of the clypeus, small spot back of the eye, and basal part of mandibles, all of which are light yellow; clypeal border fuliginous in color, with two broad blunt denticles between which there is a carina-like extension, medially depressed; clypeal process sides converging to a narrow, rounded apical end; mandibles that are light fuscous in color apically have two denticles, the more apical one the larger; antennae ferruginous basally becoming darker apically, normal in form.

Thorax black except for two widely separated patches on the pronotum, and the entire metanotum, both of which are yellow, and the tegulae, which are ferruginous; tegulae low and smooth; enclosure deeply ridged with the lateral ridges diverging posteriorly and a group of transverse ridges on the posterior part; mesosternal tubercles absent; legs ferruginous except for the basal end of the coxae, which are black; wings subhyaline.

Abdomen black except for tergum 1, anterior part of tergum 2, medium-broad but emarginate bands on terga 3 and 4, and broad band on posterior part of tergum 5, all of which are light yellow; venter black except the first two sterna, which are ferruginous; pygidium with sides converging to a rounded apical end.

MALE.—Unknown.

C. wyomingensis Scullen is very close to *C. nebrascensis* H. S. Smith in size, general color, and distribution, but the form of the clypeal process will separate them; however, this process shows considerable variation in form on each species. More collecting and field studies may show a closer affiliation.

TYPES.—The type female of *C. wyomingensis* Scullen, from 28 miles east of Laramie, Wyo., 7700 ft., Aug. 6, 1934, at *Cleome serrulata* (H. A. Scullen), is deposited at the U.S. National Museum, no. 66172. Paratypes are as follows:

NORTH DAKOTA: ♀, Breien, Aug. 21, 1922, at *Eriogonum annuum* (O. A. Stevens). WYOMING: ♀, 28 mi. E. Laramie, 7700 ft., Aug. 6, 1934, at *Cleome serrulata* (H. A. Scullen).

DISTRIBUTION.—Southern North Dakota and eastern Wyoming.

PREY RECORD.—None.

PLANT RECORD.—*Cleome serrulata* (Wyoming), *Eriogonum annuum* (North Dakota).

Unrecognized Species

Owing to the inadequate description and lack of types, the following species is unrecognizable at present.

78. *Cerceris townsendi* Viereck and Cockerell

Cerceris townsendi Viereck and Cockerell, 1904, p. 140.—Scullen, 1951, p. 1010.

FEMALE.—Length 7 mm. Black with yellow markings. The inadequate description does not include mention of the clypeal structures nor several other characters found useful by the present writer. From its size, it would appear to belong to Group I; however, the "testaceous" stigma makes its position uncertain.

TYPE.—The type female, from Las Cruces, N. Mex. (Townsend), should be at the Philadelphia Academy of Natural Sciences, but it is not included in the list of types published by E. T. Cresson, Jr. (1928), and the writer has been unable to find it at the above institution. The species is known only from the published description.

PREY RECORD.—None.

PLANT RECORD.—None.

Species of *Cerceris*

Valid names appear without parentheses: synonyms, with; names of species changed in status from the original by this or previous publications are in brackets. Page numbers of principal references are in italics.

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aequalis idahoensis Scullen, 344, *454–455*
(*alacris* Mickel), 483, 484
(*alaope* Banks), 474, 475
alceste Mickel, 343, 454, *455–456*
(*ampla* Banks), 438, 439
(*arbuscula* Mickel), 458, 459
(*architis* Mickel), 336, 483, 484
[*arelate* Banks], 495, 496
argia Mickel, 346, 351, *357–359*, 394
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[*athene* Banks], 337, 437, 438
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(*austrina* Fox), 423, 424, 426, 428
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banksi Scullen, 343, 459, *461–462*
(*belfragei* Banks), 418, 420
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bicornuta bicornuta Guérin, 335, 336, 345, 349, *462–465*, 466, 481, 489, 503, 504
bicornuta fidelis Viereck and Cockerell, 337, 345, 349, 464, *465–466*
(*biungulata* Cresson), 505, 506
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bridwelli Scullen, 346, 351, *361–363*, 375
bulleri Scullen, 346, 361, *363–364*
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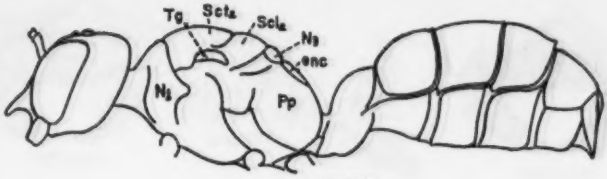


Fig.103

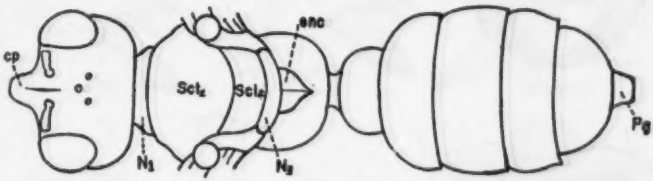


Fig.104

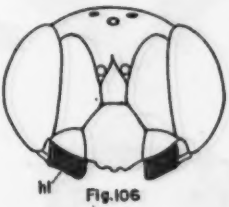


Fig.106

Fig.105

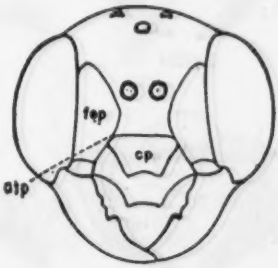
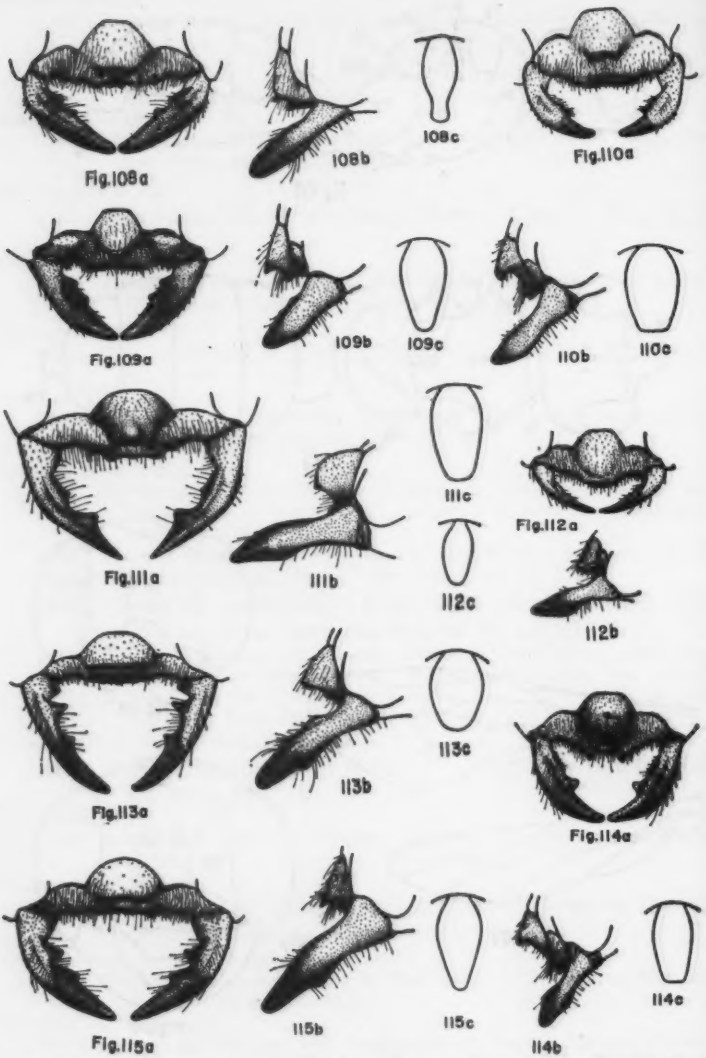
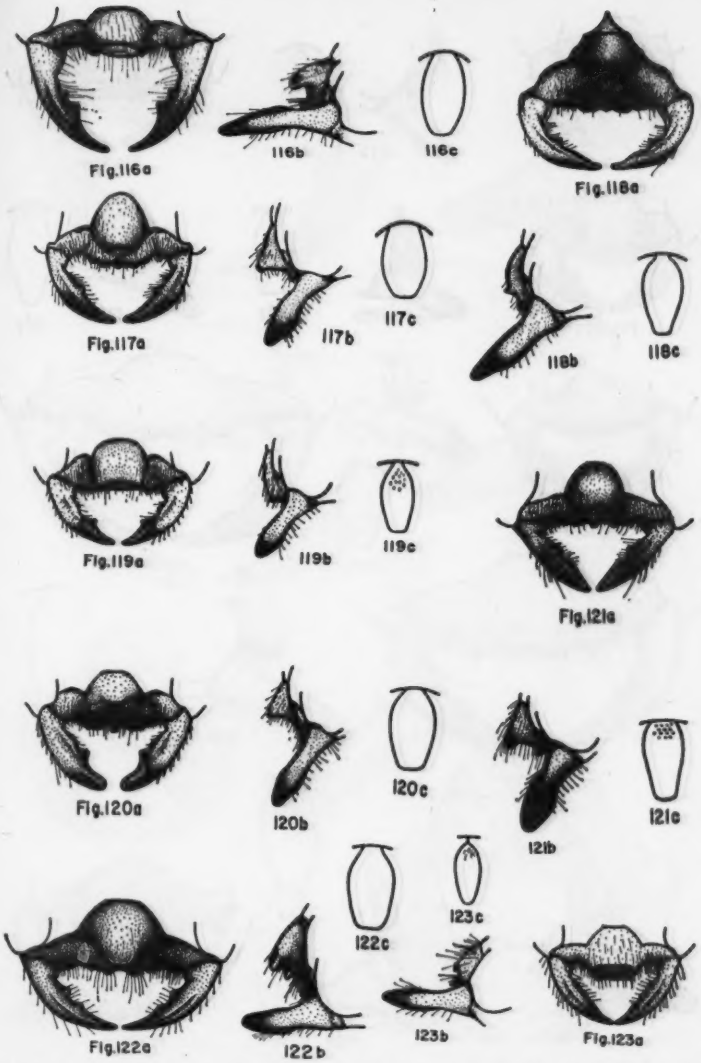


Fig.107

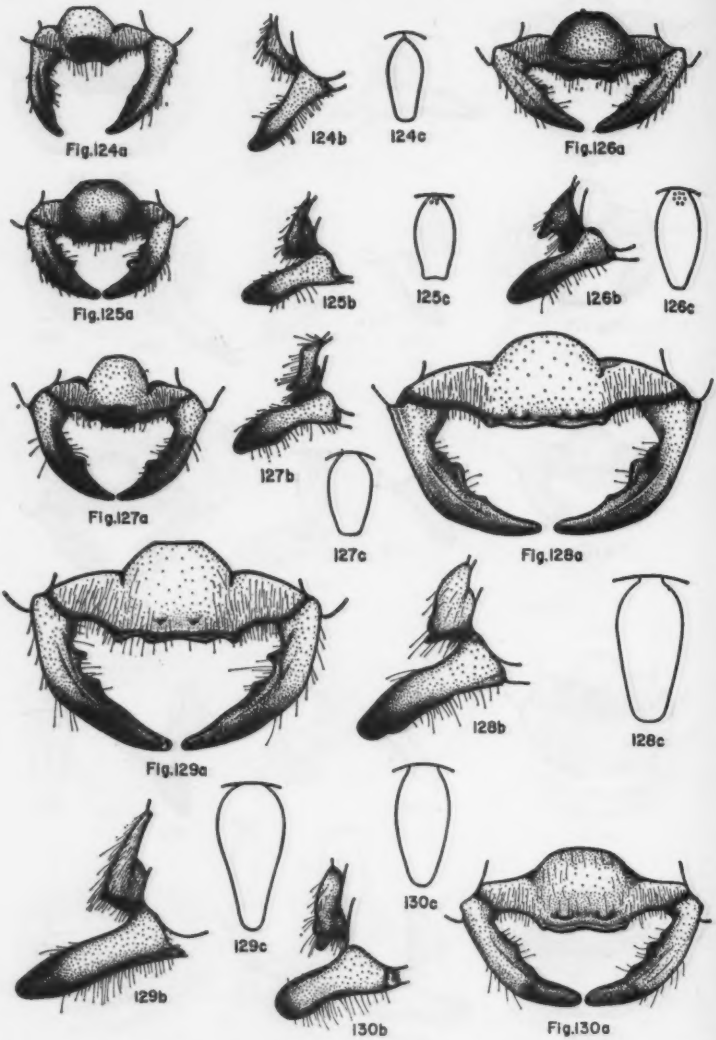
FIGURES 103–107.—103, Lateral aspect of female; 104, dorsal aspect of female; 105, wings of female; 106, face of male; 107, face of female. (Abbreviations: atp=anterior tentorial pits, cp=clypeal process, enc=enclosure, hl=hair lobes, N_1=pronotum, N_3=metanotum, Pg=pygidium, Pp=propodeum, Scl_2=scutellum, Sct_2=scutum, tg=tegula.)



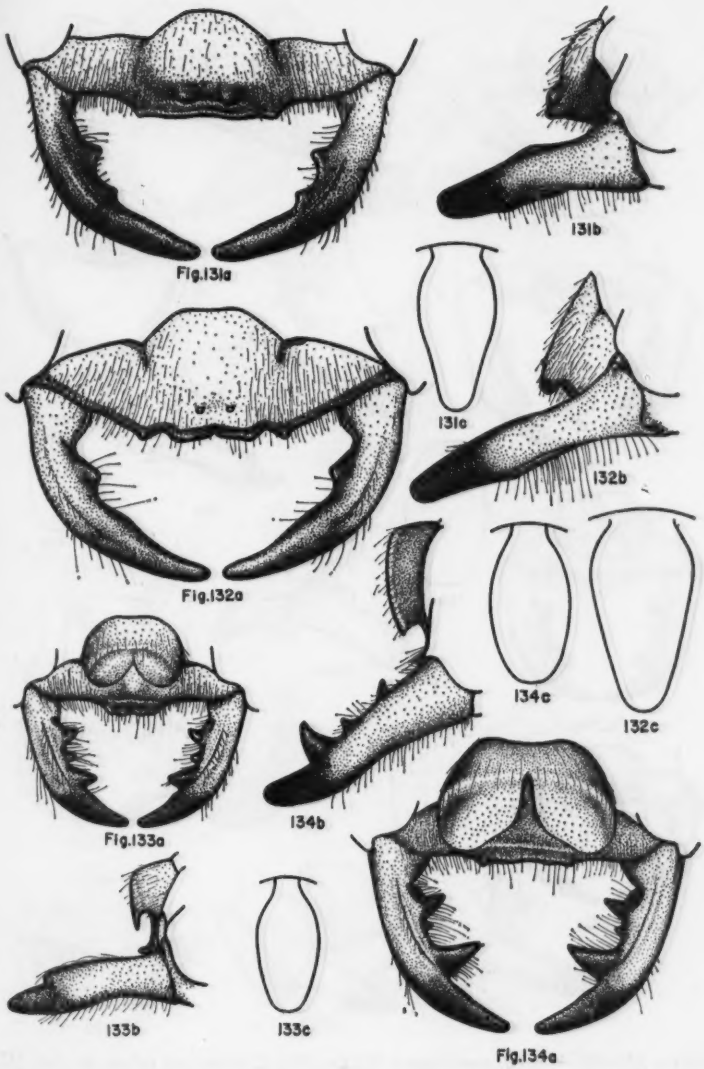
FIGURES 108–115.—108, *C. acanthophila* Cockerell; 109, *C. argia* Mickel; 110, *C. blakei* Cresson; 111, *C. bridwelli* Scullen; 112, *C. butleri* Scullen; 113, *C. chilopsidis* Viereck and Cockerell; 114, *C. conifrons* Mickel; 115, *C. convergens* Viereck and Cockerell. (*a*=lower face of female, *b*=profile of female, *c*=pygidium of female.)



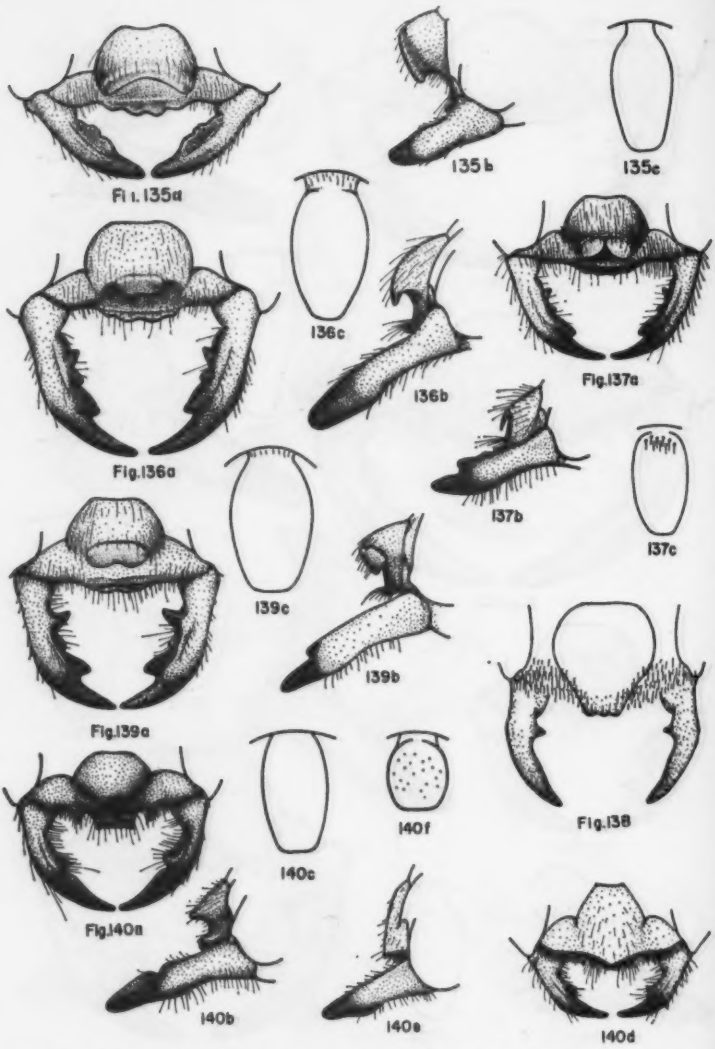
FIGURES 116–123.—116, *C. crandalli* Scullen; 117, *C. crotonella* Viereck and Cockerell; 118, *C. echo echo* Mickel; 119, *C. finitima finitima* Cresson; 120, *C. irene* Banks; 121, *C. kennicottii kennicottii* Cresson; 122, *C. krombeini* Scullen; 123, *C. neahminax* Scullen. (*a*=lower face of female, *b*=profile of female, *c*=pygidium of female.)



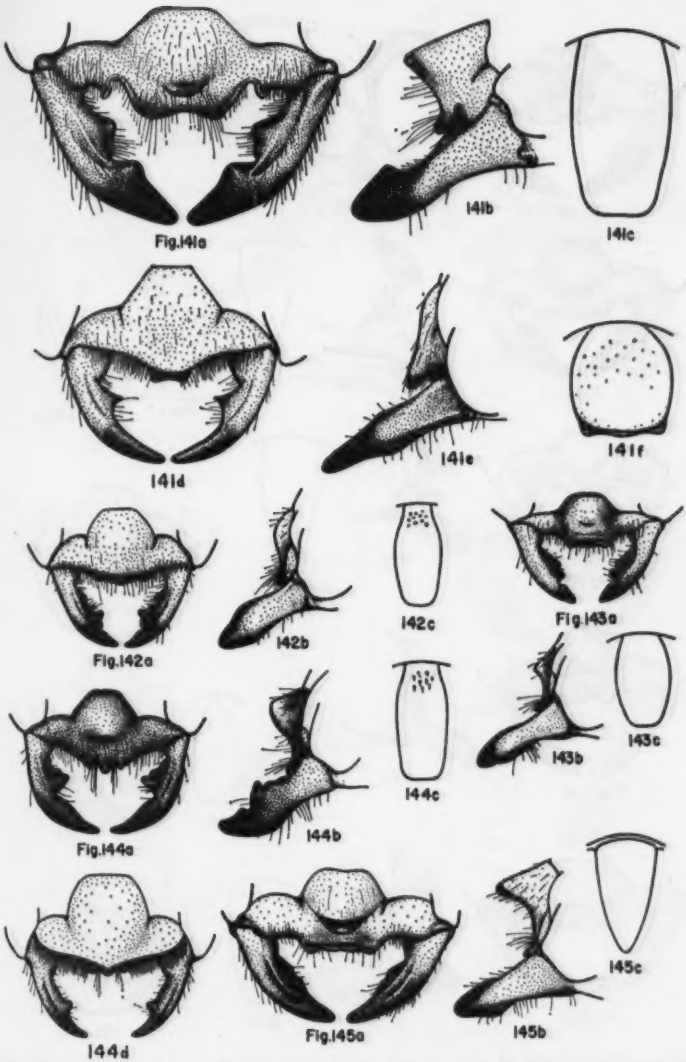
FIGURES 124–130.—124, *C. poculum* Scullen; 125, *C. rufinoda rufinoda* Cresson; 126, *C. truncata* Cameron; 127, *C. vanduzei vanduzei* Banks; 128, *C. californica californica* Cresson; 129, *C. completa* Banks; 130, *C. dilatata dilatata* Spinola. (*a*=lower face of female, *b*=profile of female, *c*=pygidium of female.)



FIGURES 131–134.—131, *C. fumipennis* Say; 132, *C. grandis grandis* Banks; 133, *C. compacta compacta* Cresson; 134, *C. flavofasciata flavofasciata* H. S. Smith. (*a*=lower face of female, *b*=profile of female, *c*=pygidium of female.)



FIGURES 135–140.—135, *C. mandibularis* Patton; 136, *C. robertsonii robertsonii* Fox; 137, *C. robertsonii bifidus* Scullen; 138, *C. rufopicta* F. Smith, lower face of male; 139, *C. squamulifera* Mickel; 140, *C. femurrubrum* Viereck and Cockerell. (*a*=lower face of female, *b*=profile of female, *c*=pygidium of female, *d*=lower face of male, *e*=profile of male, *f*=pygidium of male.)



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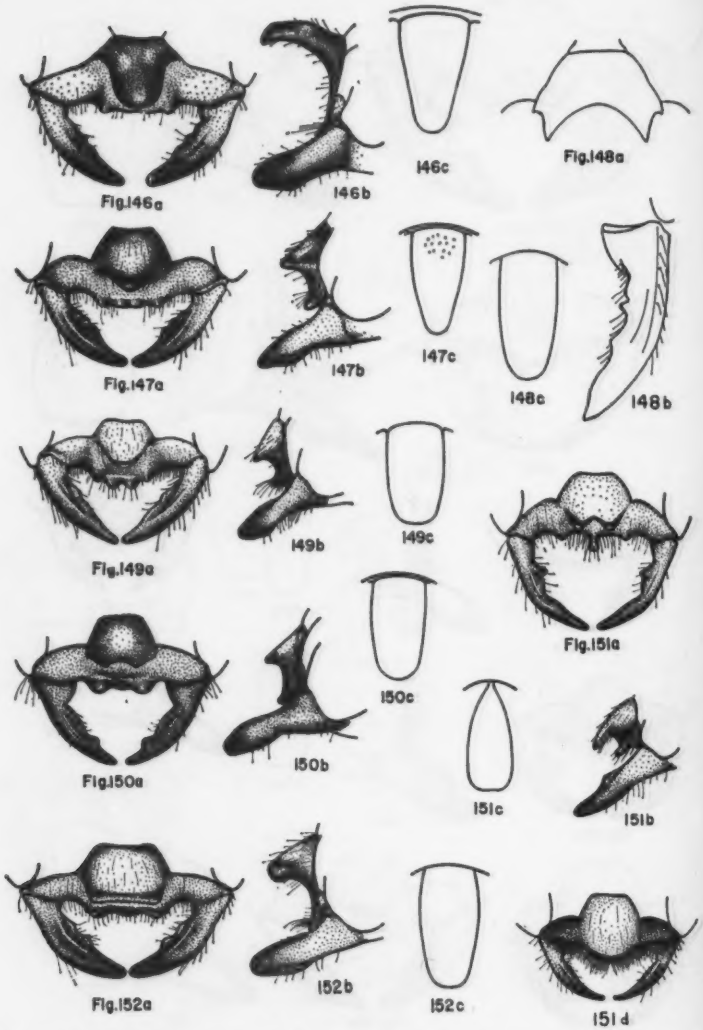

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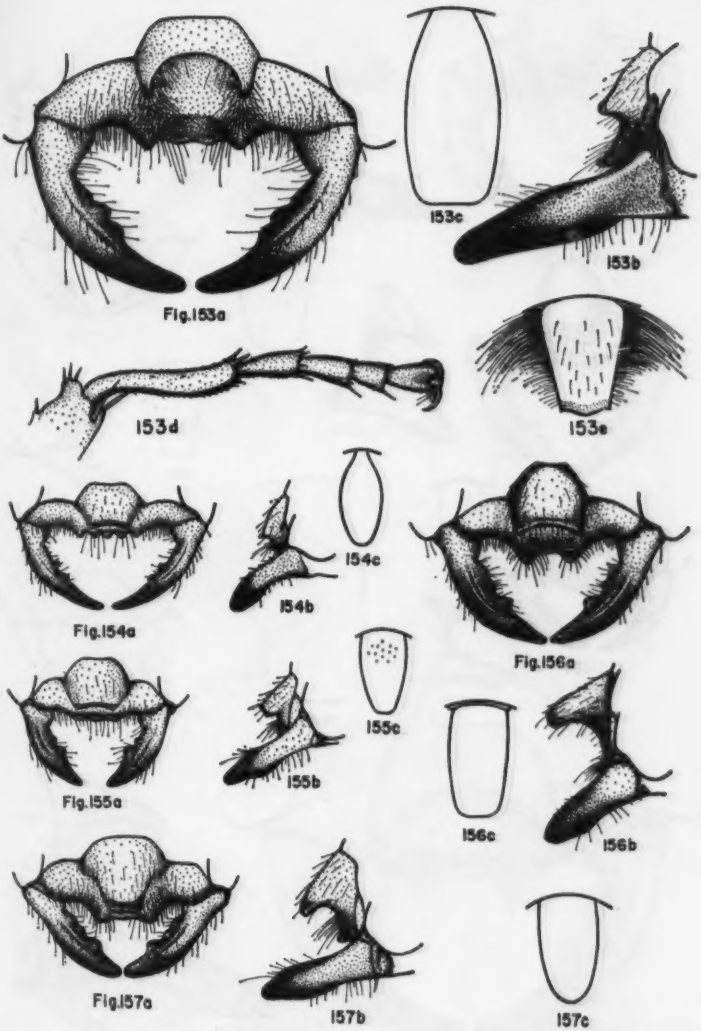

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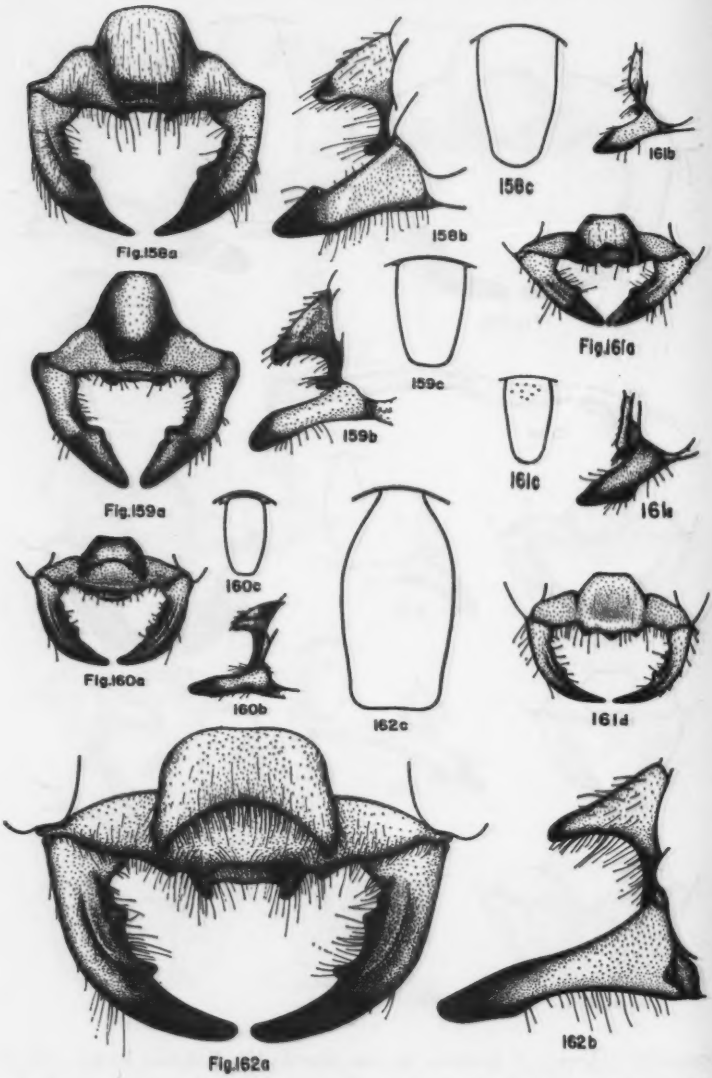
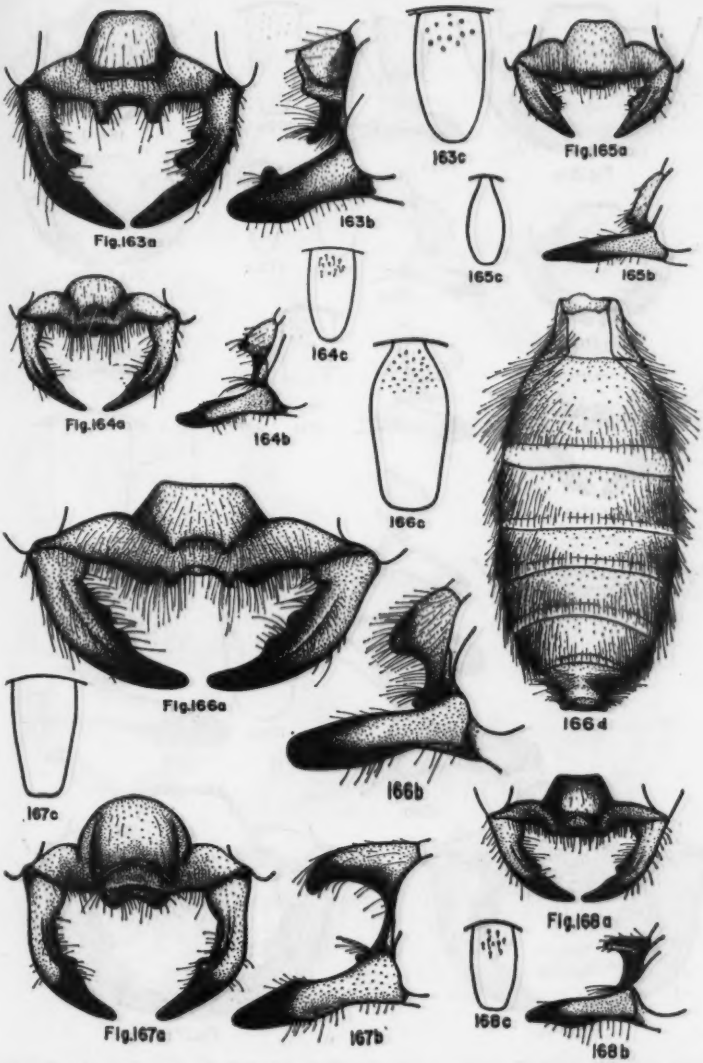


FIGURES 158–162.—158, *C. clypeata gnarina* Banks; 159, *C. clypeata prominens* Banks; 160, *C. dentifrons* Cresson; 161, *C. deserta* Say; 162, *C. frontata frontata* Say. (*a*=lower face of female, *b*=profile of female, *c*=pygidium of female, *d*=lower face of male; *e*=profile of male.)



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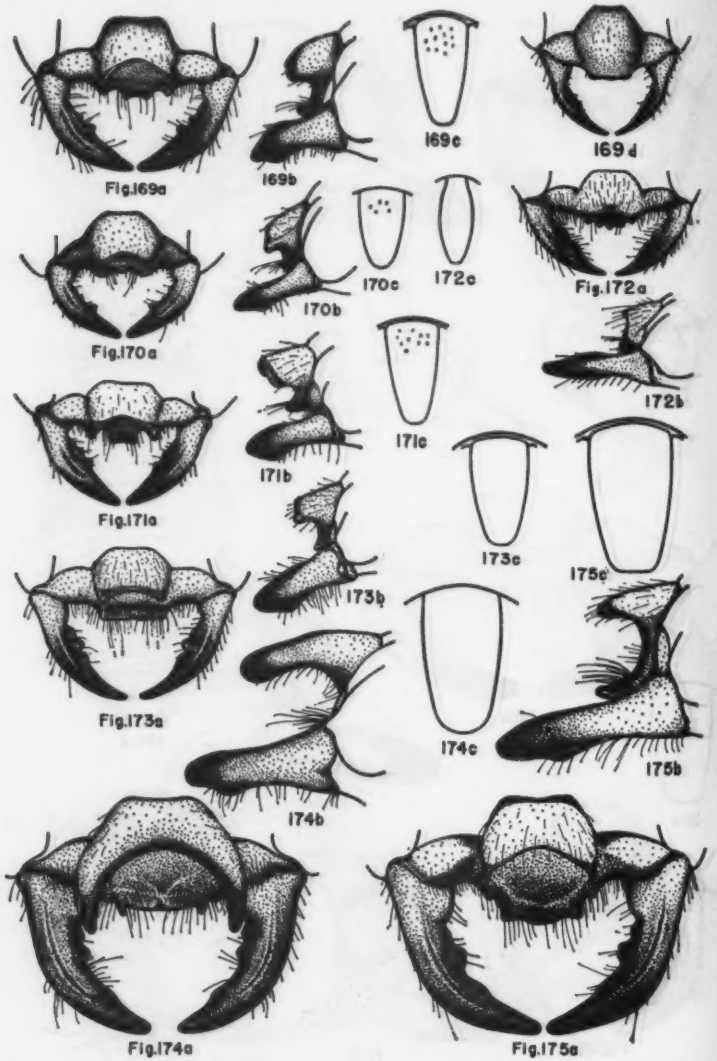

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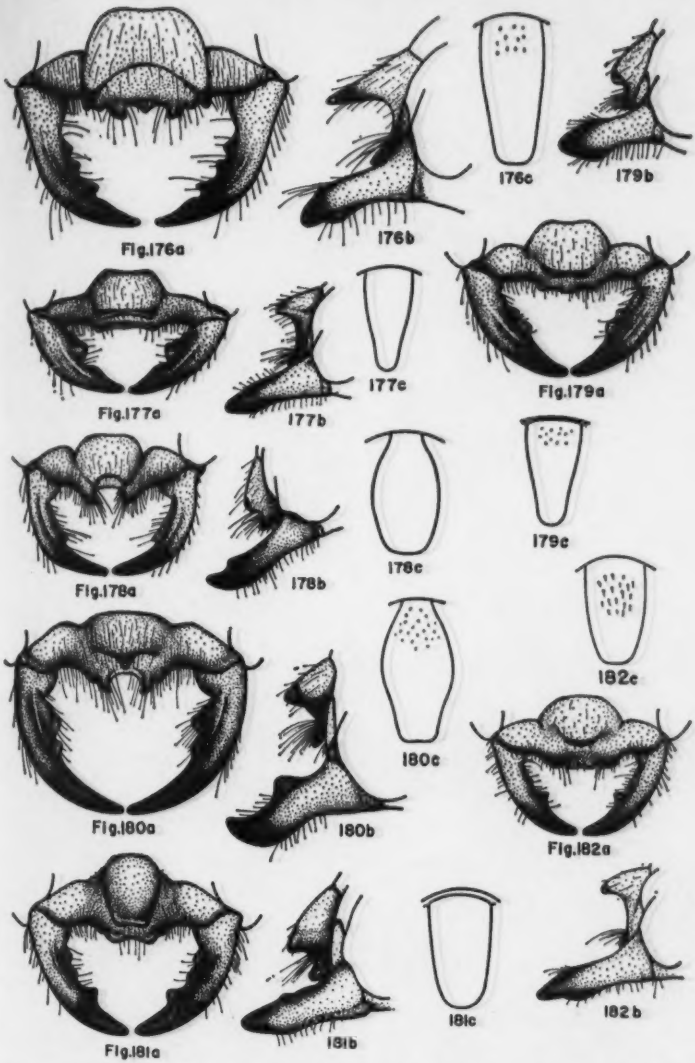

FIGURES 176–182.—176, *C. tepaneca* Saussure; 177, *C. texana* Scullen; 178, *C. tolteca* Saussure; 179, *C. varians* Mickel; 180, *C. verticalis* F. Smith; 181, *C. vicina* Cresson; 182, *C. wyomingensis* Scullen. (*a*=lower face of female, *b*=profile of female, *c*=pygidium.)

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NORTH AMERICAN MOTHS OF THE GENUS SWAMMERDAMIA (LEPIDOPTERA: YPONOMEUTIDAE)

By W. DONALD DUCKWORTH

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Volume 116 1965 Number 3507

NORTH AMERICAN MOTHS OF THE GENUS SWAMMERDAMIA (LEPIDOPTERA: YPONOMEUTIDAE)

By W. Donald Duckworth

Friese (1960), in his recent revision of the Palaearctic Yponomeutidae, proposed a more natural arrangement of the complex of species previously grouped in the genus *Swammerdamia* Hübner. The Palaearctic species are now divided into three genera, *Pseudoswammerdamia* Friese, *Swammerdamia* Hübner, and *Paraswammerdamia* Friese. In light of this new arrangement it seemed appropriate to examine the two species of *Swammerdamia* described from North America to determine how they fit into this new scheme.

The first record of the genus *Swammerdamia* in North America was published by Busck (1911) when he reported collecting specimens identified by him as *Swammerdamia pyrella* (De Villers) at Monadnock Lake, N.H. Three years later Busck (1914) stated that he had misidentified the specimens from New Hampshire as *S. pyrella* and that they actually represented a new species which he described as *S. castaneae*. Braun (1918) described a second species, *S. cuprescens*, reared from birch in Field, British Columbia. Clarke (1942) reported the first authentic record of *S. pyrella* (De Villers) from Bellingham, Wash., bringing the known North American species to three.

Examination of the genitalia of the types and specimens compared with the types of the two American species, *S. castaneae* and *S. cuprescens*, has revealed some interesting new facts that permit a clearer understanding of the occurrence of this predominantly Palaearctic group in the Nearctic Region. The results of these findings are presented in the present paper.

I wish to thank Dr. J. G. Franclemont for permitting me to study material from the Cornell University Collection, Dr. T. N. Freeman for providing records from material in the Canadian National Collection, Dr. G. J. Spencer for lending specimens from the University of British Columbia Collection, and Dr. Annette F. Braun, Cincinnati, Ohio, for comparing material from the United States National Museum with the type of *S. cuprescens* Braun in her personal collection.

Genus *Swammerdamia* Hübner

Swammerdamia Hübner, 1825, Verzeichniss bekannter Schmettlinge [sic], p. 425. (Type species, *Tinea pyrella* De Villers).

Head rough. Labial palpus short, porrect. Forewing semilanceolate, terminal cilia long; 11 veins, all separate; 2 from well before angle; 3 from angle; 6 absent; 7 to termen. Hindwing slightly narrower and more lanceolate than forewing, with a subbasal hyaline patch; 7 veins, all separate; 4 absent.

Male genitalia: Harpe simple, sacculus large; ventral plate of the gnathos lightly sclerotized, broad, armed with numerous small spines or nodules; saccus slender, approximately parallel sided; aedeagus with cornuti.

Female genitalia: Anterior apophyses short, ventral arms widening at tips; lamella postvaginalis with a pair of fingerlike setiferous lobes; ostium bursae with dentate signum.

Key to the North American Species of *Swammerdamia* Based on the Genitalia

1. Male 2
   Female 3
2. Aedeagus short, straight, pointed at apex; one or more long, heavy setae on sacculus of harpe . . . . . **S. pyrella** (De Villers)
   Aedeagus long, crooked, bluntly pointed at apex; sacculus without long, heavy setae . . . . . **S. heroldella** Hübner
3. Ductus bursae with granular sclerotizations on posterior half, shorter than length of abdomen . . . . . **S. pyrella** (De Villers)
   Ductus bursae membranous, much longer than length of abdomen **S. heroldella** Hübner

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***Swammerdamia pyrella* (De Villers)**

FIGURES 2*a*,*b*,*e*, 3*a*

Tinea pyrella De Villers, 1789, Caroli Linnaei entomologia faunae Suecicae . . . , vol. 2, p. 515.

Tinea cerasiella Hübner, 1810–13, Sammlung europäischer Schmetterlinge, vol. 8, Tin. taf. 48, fig. 332.

Oecophora passerella Zetterstedt, 1840, Insecta Lapponica, p. 1009.

Swammerdamia variegata Tengström, 1869, Notis. Sällsk. Fauna Flora Fennica Forh., vol. 10, p. 364.

Swammerdamia nanivora Stainton, 1871, Entomologist's Annual, 1871, p. 96.

Alar expanse 9–12 mm.

Antenna whitish basally, fuscous beyond. Head white; labial palpus gray, tip of apical segment whitish. Legs gray. Thorax dark gray dorsally. Forewing gray, overcast to a greater or lesser degree with fuscous scales; a white anteapical costal spot; cilia fuscous with a coppery lustre. Hindwing gray, cilia gray.

Male genitalia: See figures (slide WDD 3195). Harpe broad with one or more large, heavily sclerotized, long setae on sacculus, ventral edge of sacculus with several short, heavy setae usually grouped in pairs; ventral plate of the gnathos with numerous small nodules; aedeagus short, straight, pointed at apex; vesica armed with cornuti.

Female genitalia: See figures (slide WDD 3196). Ductus bursae with granular sclerotizations on posterior half, shorter than length of abdomen; corpus bursae with signum a sclerotized, dentate plate.

Type: Lost.

Type locality: Southern France.

Food plant: Friese (1960) reports the larvae from *Pyrus communis* L., *Malus silvestris* Mill. (=*Pyrus malus* L.), *Prunus cerasus* L., *Prunus domestica* L., *Crataegus* spp., and in northern Europe on *Betula nana* L.

Distribution: BRITISH COLUMBIA: Fraser Mills (July, Aug.). WASHINGTON: Bellingham (Aug.).

The first authentic record of this species in North America was published by Clarke in 1942, as was mentioned earlier. It is undoubtably an introduction from Europe, most likely brought in with plant material imported for the vast orchards of the Pacific Northwest. A very common and widespread species in Europe, *S. pyrella* does not seem to have established itself as well in North America; however, due to its small size and dull color, it may well be that it has been overlooked by most collectors.

Although rather indistinct in coloration, *S. pyrella* is readily recognizable by characters of the genitalia. These characters have been noted in the key, and examination of the figures readily illustrates them.

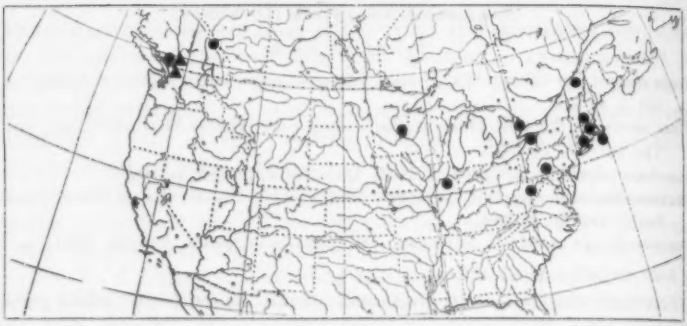

FIGURE 1.—Distribution records of the North American species of *Swammerdamia*.
▲ *pyrella* ● *heroldella*

***Swammerdamia heroldella* Hübner (sensu Treitschke, 1833)**

FIGURES 2*c,d*, 3*b*

Tinea caesiella Hübner, 1796, Sammlung europäischer Schmetterlinge, vol. 8, p. 65, pl. 25, fig. 172.

Swammerdamia heroldella Hübner [new name for *caesiella*], 1825, Verzeichniss bekannter Schmettlinge [sic], p. 425.

Lita heroldella Treitschke, 1833, Die Schmetterlinge von Europa, vol. 9, p. 97.

Tinea nubeculella Tengström, 1848, Notis. Sällsk. Fauna Flora Fennica Forh., vol. 1, p. 3.

Tinea griseocapitella Stainton, 1851, Catalogue of the British Tineidae and Pterophoridae, suppl., p. 3.

Swammerdamia castaneae Busck, 1914, Proc. Ent. Soc. Washington, vol. 16, p. 148. (New synonymy.)

Swammerdamia cuprescens Braun, 1918, Canadian Ent., vol. 50, p. 231. (New synonymy.)

Alar expanse 9–13 mm.

Antennae whitish basally, fuscous annulated with white beyond. Head and face white; labial palpus fuscous, tip of apical segment whitish. Legs light to dark gray, tarsi more or less annulated with white. Thorax white to gray dorsally. Forewing grayish white variably overcast with fuscous scales; white anteapical costal spot either present or absent; cilia fuscous with a coppery lustre. Hindwing pale to dark gray, cilia gray.

Male genitalia: See figures (slide WDD 3025). Harpe narrow basally with numerous short, heavy setae on ventral edge of sacculus; ventral plate of gnathos with numerous small spines; aedeagus long, crooked, bluntly pointed at apex; vesica armed with cornuti.

Female genitalia: See figures (slide WDD 3003). Ductus bursae membranous, much longer than length of abdomen; corpus bursae with signum a sclerotized, dentate plate.

Type: Lost.

Type locality: Unknown.

Food plant: *Betula* spp., *Alnus* spp., *Castanea dentata* (Marsh.).

Distribution: BRITISH COLUMBIA: Field (Aug.); Fraser Mills (May). CONNECTICUT: East River (Aug.). ILLINOIS: Putman Co. (May, July, Aug.). MASSACHUSETTS: Framingham (May); Martha's Vineyard (Aug.). MINNESOTA: Chisago Co. (May). NEW HAMPSHIRE: Dublin (Aug.). ONTARIO: Toronto (July); Queenston (June). PENNSYLVANIA: Charter Oak (March). QUEBEC: Newago, Lake St. Francis (July). WEST VIRGINIA: Randolph Co. (May).

I have examined the genitalia of Busck's type of *S. castaneae* and a specimen compared with Braun's type of *S. cuprescens* and found them identical to each other and to the European species *S. heroldella*. This species is rather variable in color. It has been the subject of a great deal of controversy among European workers, as the synonymy will attest. Friese (1960) has reviewed the subject, and I follow his conclusions concerning the synonymy in this paper. The failure of Busck and Braun to recognize the species as *S. heroldella* was most probably due to the state of confusion among the European workers regarding this species.

As is the case with the preceding species, *S. heroldella* is undoubtably an introduction from Europe brought in on plant material. The diversity in the type localities (Field, British Columbia, for *S. cuprescens* and East River, Connecticut, for *S. castaneae*) of the two North American synonyms suggests either a much more widespread distribution than the preceding species, *S. pyrella*, or two independent introductions, one on the east coast and one on the west coast.

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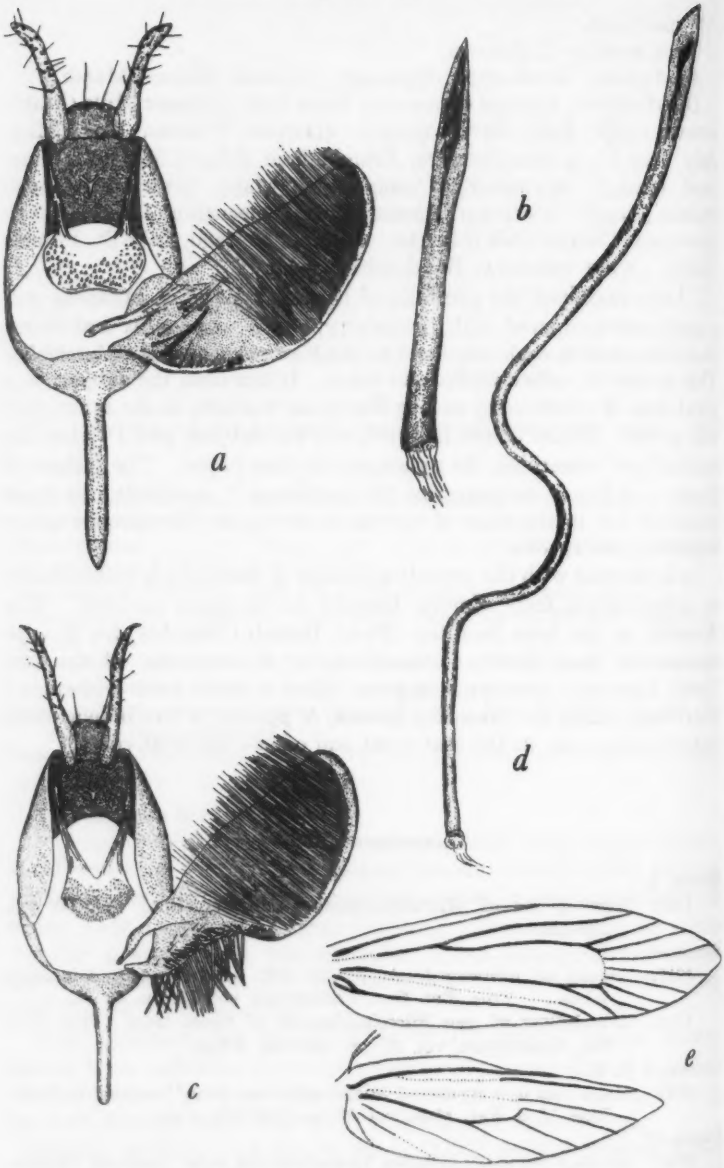

FIGURE 2.—*Swammerdamia pyrella* (De Villers): *a*, ventral view of male genitalia with aedeagus removed; *b*, aedeagus; *e*, wing venation. *S. Heroldella* Hübner: *c*, ventral view of male genitalia with aedeagus removed; *d*, aedeagus.

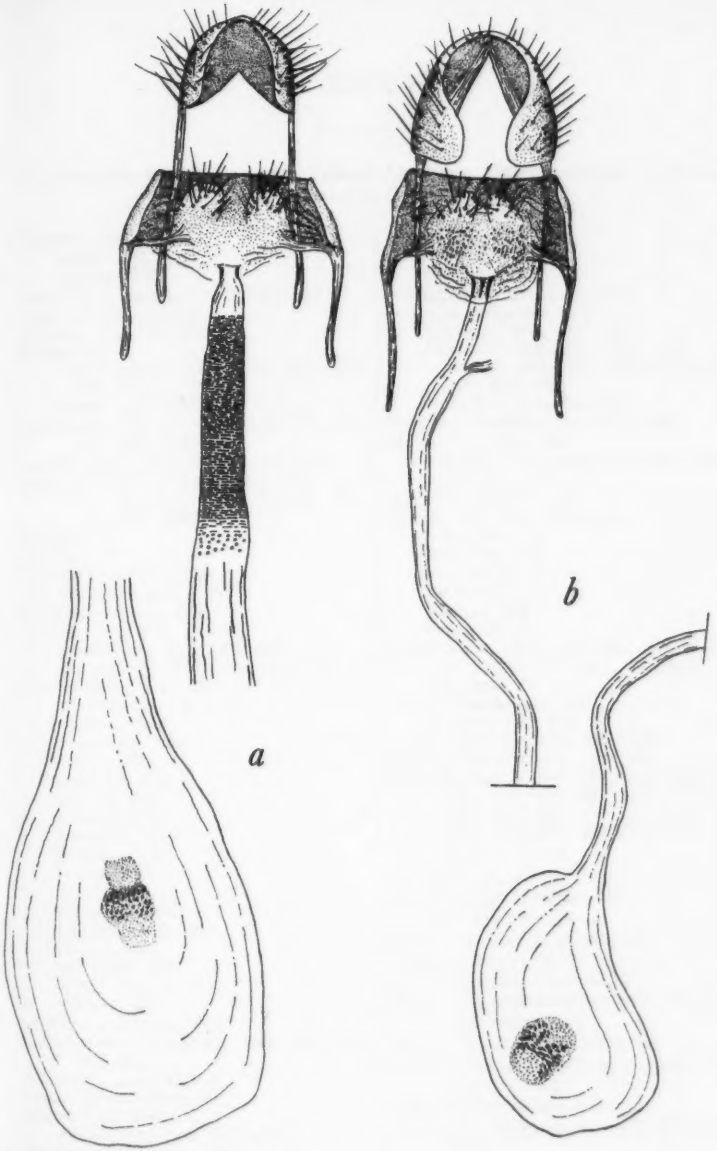

FIGURE 3.—*Swammerdamia pyrella* (De Villers): *a*, female genitalia. *S. heroldella* Hübner: *b*, female genitalia.

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